HUSKY MP2500

System Developer's Guide

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ELECTROMAGNETIC COMPATIBILITY (EMC)

! CAUTION !

Approved accessories only may be used with this equipment. In general all cables must be high quality, shielded, correctly terminated and normally restricted to 2 metres length. MP2500 AC Adaptors employ special provisions to avoid radio interference and should not be altered or substituted.

Unapproved modifications or operation beyond or in conflict with these instructions for use may void authorisation to operate the equipment.

Europe

This apparatus complies with the radio interference protection requirements of the Council Directive 89/336/EC on the approximation of the laws of the Member States of the European Union relating to electromagnetic compatibility. The product was tested in a typical configuration and found to conform to the following test specifications:

EN55022 Radiated and conducted emissions, Class B.

EN50082 ESD and radiated and conducted immunity.

For further compliance details, refer to the specific CE Declaration Of Conformity. This is available on request, quote the exact and full order code for the product(s) in question.

USA

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canada

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations (ICES-003).

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada (NMB-003).

DISPOSAL OF NiCd RECHARGEABLE BATTERIES

- If the **MP2500** is used with rechargeable **nickel cadmium** batteries, these should be disposed of properly at the end of their life.
- Products containing nickel and cadmium require special attention.
- Such materials are hazardous to the environment, please recycle.
- Always take note of any instructions printed on the battery.
- It may be illegal to dispose of such materials via your public waste system.
- Check with your local solid waste authority for proper instructions.

DISPOSAL OF NiMH RECHARGEABLE BATTERIES

- If the **MP2500** is used with rechargeable **nickel metal hydride** batteries, these should be disposed of properly at the end of their life.
- Always take note of any instructions printed on the battery.
- It may be illegal to dispose of such materials via your public waste system.
- Check with your local solid waste authority for proper instructions.

INTERNAL BATTERIES, non user-accessible

- The MP2500 contains the following internal batteries:
  - Nickel metal hydride rechargeable cell
  - Lithium non-rechargeable cell
- It may be illegal or inadvisable to dispose of such materials via your public waste system.
- Check with your local solid waste authority for proper instructions.
- If you are responsible for product disposal, the internal batteries may be extracted by removing the ring of case screws, opening the case halves, locating the batteries and either unplugging or cutting the supporting leads.

AC ADAPTOR PRECAUTIONS

USE THE AC POWER ADAPTOR ONLY AFTER READING AND UNDERSTANDING THE FOLLOWING PRECAUTIONS.

HUSKY AC Adaptors are class II (double insulated with no earth) and built to EN60950: 1988 or EN60742: 1989, BS415 and DIR73/23/EEC safety requirements, and international EMC standards including EN55022 classes A & B.

HUSKY AC Adaptors supplied for use in North America meet UL safety requirements, FCC Part 15 EMC regulations (classes A and B) and CSA EMC regulations (classes A and B).

- Hazardous voltages inside, do not attempt to open.
- No user serviceable parts inside, do not attempt to open.
- Indoor use only.
- Avoid liquid spillage, do not connect if suspected damp.
- Ensure ventilation is not restricted.
- Use only the **HUSKY MP2500** AC Adaptor. This special adaptor should never be replaced by an alternative unapproved model, as damage may result.
- Inspect adaptor before connecting, do not use if there are signs of damage or deterioration.
- Ensure rechargeable batteries are fitted and they are orientated correctly.
- Battery chemical leakage is corrosive, do not touch. (In case of accidental contact wash immediately with running water.)
- Ensure that connectors are firmly mated.
- Avoid mechanical strain to cables or connectors.
- Switch on or connect mains (line) supply only after making all connections.
- Switch off or disconnect mains (line) supply before disconnecting.

- In the event of overloading due to a fault, the adaptor is designed to be fail safe and may stop functioning.
- Do not attempt to employ the AC Adaptor for alternative purposes.
- Use only a readily accessible power outlet, and disconnect when not in use.
- Although the AC Adaptor is rated for continuous operation, it is important not to exceed the charging limitations of the battery. Refer to appropriate instructions on charging regime.
- Avoid use in dusty or contaminated environments.

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Table of Contents

PART 1 INTRODUCTION

1. Welcome to the HUSKY MP2500 1
1.1 The MP2500 system 2
1.2 Features 2
1.3 Options 3

2. The MP2500 Guides 5
2.1 The HUSKY Web Site 6

3. Using this Guide 7
3.1 Structure 7
3.2 Suggested reading approach 8
3.3 Conventions 9

PART 2 SETTING UP

4. Introduction 11

5. Setting Up 13
5.1 About the MP2500 13
5.2 Fitting batteries 15
5.3 Turning on 16
5.3.1 Turning on for the first time 16
5.3.2 Turning on at other times 17
5.4 Configuring the MP2500 18
5.4.1 Power management 18
5.4.2 Time and date 18
5.4.3 Serial port 19
5.4.4 System files 19
5.4.5 International keyboards 19
5.5 Non-volatile configuration 20
5.5.1 Rebooting 21
5.6 Installing the application 21
5.6.1 Copying the files 21
5.6.2 Setting up the application 21
5.6.3 Running the application 21
5.6.4 Default files shipped with MP2500 22
5.6.5 Year 2000 compliance 23

6. Issuing the Unit 25

7. Using the MP2500 27
7.1 Turning on and off 27
7.2 Rebooting 27
7.3 The screen 28
7.3.1 Introduction 28
7.3.2 Visibility 29
7.3.3 Moving around the virtual screen 30
7.3.4 Split screen 31
7.3.5 Inverse video 32
7.4 The keyboard 33
7.4.1 Introduction 33
7.4.2 Keyboard options 34
7.4.3 Keyboard modes 34
7.4.4 Normal keys (default keyboard mode) 35
7.4.5 Shifted keys (default keyboard mode) 36
7.4.6 Special keys 37
7.5 Using MS-DOS 38
7.6 EMC legislation 40

8. Regular Maintenance 41
8.1 Routine maintenance and checks 41
8.2 Power 42
8.2.1 Introduction 43
8.2.2 Using rechargeable batteries 44
8.2.3 Using non-rechargeable batteries 49
8.2.4 Using the AC adaptor 51
8.2.5 The power management system 52
8.3 The handstrap 55
8.4 The keyboard overlay 57
8.5 Storage 58
8.6 Repairs and upgrades 58

9. Troubleshooting 59
9.1 Common Problems 59
9.1.1 Programming errors 59
9.1.2 Physical abuse 59
9.1.3 Operation outside specified temperature range 60
9.1.4 Keyboard operation 60
9.1.5 Pressure differences 60
9.2 Diagnosing and Solving Problems 61
9.3 Checks 66
9.3.1 Communications 66
9.3.2 Real Time Clock (RTC) 66
9.3.3 Files 66

10. The Utilities 69
10.1 The UTIL utility 69
10.1.1 Using UTIL 70
10.1.2 Set time 71
10.1.3 Set date 71
10.1.4 Format diskette 72
10.1.5 Communication Port Setup 73
10.1.6 Non-volatile configuration 74
10.1.7 Command line switches 75
10.2 The BOOT OPTION menu 76
10.2.1 Booting from a diskette 77
10.3 The ORACLE utility 79
10.4 Formatting a CompactFlash drive 80
10.5 The INTERLINK utility 82

11. The HOT Key 85
11.1 Introduction 85
11.2 Status information 86
11.3 Screen option 86
11.3.1 Text font 86
11.3.2 Inverse video 87
11.3.3 Split screen 87
11.3.4 Cursor synchronisation 87
11.4 Keyboard option 88
11.4.1 Backlight timeout 88
11.4.2 Turnoff timeout 88
11.4.3 Autorepeat 89
11.5 Power option 89
11.5.1 Battery Charging Support: Disabled 89
11.5.2 Battery Charging Support: Enabled 89
11.5.3 Charging type 89
11.5.4 Charging termination 90

12. The Editor 91
12.1 Introduction 91
12.2 Selecting ED 91
12.3 File handling 91
12.4 ED options 92
12.5 Editing screen 94
12.6 Facilities 96
12.7 The commands 99
12.7.1 Control Keys 100
12.7.2 Function Keys 100
12.7.3 Other Keys 101

BLOCK COPY 101
BLOCK DELETE 102
BLOCK MOVE 102
BLOCK START/END 103
BLOCK WRITE 103
CHARACTER INSERT 104
CURSOR KEYS 105
DELETE FILE 105
DELETE LEFT/RIGHT 105
DIRECTORY 106
EXIT 107
FILE START/END 107
FIND 107
LINE DELETE 108
LINE START/END 108
PAGE UP/DOWN 109
PRINT SCREEN 109
READ FILE 109
REPLACE 110
SAVE 111
SET 111
TAB 113
UNDELETE 113
VIEW FILE 114
WORD DELETE 114
WORD SKIP 114
12.8 Error Messages 115

13. Introduction to Communications 119
13.1 Introduction 119
13.2 Communications packages 120
13.3 Background information 121
13.3.1 Buffering 121
13.3.2 Data Transmission 122
13.3.3 Data Reception 122
13.4 Connecting up 123
13.5 Configuring MP2500 communications 123
13.5.1 Handshaking 125
13.5.2 Protocols 126
13.5.3 Port set-up options 128
13.6 Configuring IBM communications 139
13.7 Example communications set-up 140
13.7.1 Communicating with another MP2500 (or an FS unit with a 9-way D-type) 140

13.7.2 Communicating with an FS unit equipped with 12-way (circular) connectors 141
13.7.3 Communicating with an external modem 142
13.7.4 Communicating with a PC (Personal Computer) - serial communications 143
13.7.5 Communicating with a serial printer 146

14. Using Communications 149
14.1 Introduction 149
14.2 Selecting the communications package 149
14.3 Starting communication 150
14.4 Using standard facilities 150
14.5 Using the HUSKY File Transfer Utility, HCOM 152
14.6 Using the HUSKY XMODEM Loader, XL 153
14.6.1 Using XL 153
14.6.2 Technical information 155
14.6.3 XL error messages 155
14.7 Using MP2500 applications 156
14.8 Using MS-DOS applications 156
14.9 Using MS-DOS communications packages 157
14.10 File transfers 157
14.10.1 Exchanging files with an MP2500, FS3 or FS/2 158
14.11 Troubleshooting 158

15. Accessories 161
15.1 Introduction 161
15.2 Power 161
15.3 Upgrading the BIOS and Utilities 162
15.4 Communications 162
15.5 Peripherals 162
15.5.1 Power for peripherals 162

PART 3 TECHNICAL REFERENCES

16. Introduction 163
16.1 Using this part of the guide 163
16.2 Assumptions 163
16.3 Conventions 164

17. Installing Standard Applications 165
17.1 Compatibility 165
17.1.1 Problems with interrupts 166
17.1.2 Other compatibility issues 166
17.2 Porting the application 168
17.3 Configuring 168
17.4 Testing 170

17.5 Special considerations 170
17.5.1 Batteries 170
17.5.2 Display 171
17.5.3 Training 172

18. Adapting Applications 173
18.1 Using PC-DOS or MS-DOS software 173
18.2 Using FS/2 or FS3 software 174

19. The Interrupts 175
19.1 Summary 175
19.2 BIOS interrupts 177

20. INT 05H, Print Screen Contents 179
Use 179
Entry 179
Exit 179
Comments 179

21. INT 10H, Screen Handler 181
Use 181
Entry 181
Exit 181
Comments 181
Set screen mode 183
Set cursor size 183
Move cursor 184
Get cursor position 184
Get cursor address [+][-] 184
Set display page 185
Scroll up 185
Scroll down 186
Read character and attributes 186
Write character plus attributes 186
Write character 187
Write pixel 187
Read pixel 188
Write character as TTY 188
Get video state 188
Write string [-] 189
Set graphics font [+] 189
Move cursor to graphics co-ordinates [+] 190
Get cursor position in graphics co-ordinates [+] 191
Set contrast [+] 191
Get/set backlight (option) timeout [+] 191

Split display [+] 192
Draw ellipse/circle [+] 192
Draw line/box [+] 193
Select inverse video mechanism [+] 194
Select text font [+] 195
Set LCD window position [+] 196
Looking keys [+] 197
Get graphics font [+] 197
Turn backlight (option) on/off [+] 198
Reset screen parameters [+] 198
Get contrast and backlight (option) state [+] 199
Set bold attribute mask [+] 199

22. INT 11H, Check System Equipment 201
Use 201
Entry 201
Exit 201
Comments 201

23. INT 12H, Check Memory Size 203
Use 203
Entry 203
Exit 203
Comments 203

24. INT 13H, Disk Handler 205
Use 205
Entry 205
Exit 205
Comments 206
Reset disk 207
Read disk status 207
Read sectors 207
Write sectors 208
Verify sectors 208
Format disk cylinder 209
Format bad track 210
Format drive 210
Read drive parameters 211
Initialise drive parameters 211
Read long sector 211
Write long sector 212
Seek to cylinder 212
Alternate reset disk 213
Read test buffer 213

Write test buffer 213
Test for drive ready 214
Recalibrate drive 214
Controller RAM diagnostic 214
Controller Drive diagnostic 214
Controller internal diagnostic 215
Get disk type 215

25. INT 14H, Serial Port Handler 217
Use 217
Entry 217
Exit 217
Comments 218
Initialise port 219
Send character 220
Input character 221
Check status 221
Extended initialise port [+] 221
Read comms parameters [+] 222
Select comms parameters [+] 225
Extended control [+] 228
Extended status [+] 229
Control handshake lines [+] 229
Control RI power up [+] 230
Get installed protocols count [+] 230
Get protocol name [+] 230
Get protocol handle [+] 231
Extended protocol menu [+] 231
Get extended protocol parameters [+] 231
Control NMI suspend after data reception [+] 232
Control NMI suspend after data transmission [+] 232

26. INT 15H, BIOS Extension Functions [+] 233
Use 233
Entry 235
Exit 236
Comments 236
Get/set idle timeout [+] 236
Control Resume mode [+] 237
Control STOP mode [+] 237
Power down [+] 238
Control power down [+] 238
Get ROM BIOS version number [+] 239
Get serial number [+] 239

Get event details [+] 239
Enable/trap event [+] 241
Acknowledge event [+] 242
Control sound [+] 242
Redirect serial number [+] 243
Set backlight (option) power up state [+] 243
Set contrast power up state [+] 244
Control power save [+] 244
Select serial port for redirected printing [+] 245
Invoke HOT key [+] 245
Control HOT key [+] 246
Control HOT key power option [+] 246
Override low power turn off [+] 247
Sound output [+] 247
Control screen synchronisation [+] 249
Get/set diskette drive port - 84H 249
Get/set screen attribute table [+] 249
Control power input [+] 250
Get/set power save entry flag [+] 251
Get charging status [+] 252
Reset machine information [+] 252
Get machine information [+] 253
Select soft/default font [+] 253
Get unit serial number [+] 255
Get customer id [+] 256
Resynchronise system clock with RTC [+] 256
Backlight (option) timeout mode [+] 256
Set 11x8 text font [+] 257
Set 16x16 text font [+] 258
Get/set Printer port type 259
Select INT 15H mode 259
Note that for this function, FS3 and MP2500 are synonymous. 259
Duplicated Functions 261
Get/set diskette drive port 261
Enable/disable temperature override 262

27. INT 16H, Keyboard Handler 263
Use 263
Entry 263
Exit 263
Comments 263
Get key 264
Get status 264
Get shift status 265

Set key repeat 265
Write to buffer 266
Extended get key 267
Extended get status 267
Extended get shift status 267
Set temporary shift [+] 268
Control shift keys [+] 269
Control Ctrl-Alt-Del [+] 269
Control emergency breakout [+] 270
Redefine key codes [+] 271
Reset keyboard [+] 271
Control keyclick [+] 272
Get key repeat [+] 272
Control key repeat [+] 273
Redefine key scan codes [+] 273
Redefine PAW key codes [+] 274
Control Break keys [+] 274
Select keyboard [+] 275
Reset extra keyboard variables [+] 275
Clear keyboard buffer [+] 276
Select keyclick sound [+] 277

28. INT 17H, Printer Control 279
Use 279
Entry 279
Exit 279
Comments 280
Print byte 280
Initialise printer 280
Get printer status 281

29. INT 19H, Reboot 283
Use 283
Entry 283
Exit 283
Comments 283

30. INT 1AH, Clock Handler [+] 285
Use 285
Entry 285
Exit 285
Comments 285
Get system clock 286
Set system clock 286
Get RTC time [+] 287

Set RTC time [+] 287
Get RTC date [+] 288
Set RTC date [+] 288
Set RTC alarm [+] 288
Disable RTC alarm [+] 289
Get RTC alarm time [+] 289
Set system clock source [+] 290

31. Hardware 291
31.1 Organisation 291
31.2 Memory maps 292
31.2.1 Logical memory map 292
31.2.2 Physical memory map 292
31.2.3 I/O addresses 293
31.3 Hardware interrupts 295
31.4 Device details 295
31.4.1 CGA and 6845 emulation (display) 296

32. Using Power Handling 301
32.1 The facilities 301
32.1.1 Power-up 301
32.1.2 Power-down 303
32.2 Power monitoring and charging 305
32.2.1 Power Management 305
32.3 Saving power 306
32.3.1 Power modes 307
32.3.2 Timeouts 308
32.3.3 Switchable devices 309
32.3.4 Communications and the BIOS Automatic Power Saving Features 309
32.3.5 Other situations to look out for 310
32.3.6 Using idle time 310
32.4 Calculating power usage 311
32.4.1 Rechargeable batteries 311
32.4.2 Alkaline batteries 311
32.5 Using the facilities 312
32.5.1 Setting up 312
32.5.2 Charging NiCd or NiMH batteries 314
32.6 Default charging parameter settings 314

PART 4 APPENDICES

Appendix A: Specification 315
A.1 Physical 315
A.2 Fascia 315
A.3 Programming 316
A.4 Communications 316
A.5 Screen 317
A.6 Memory 317
A.7 Clock/calendar 318
A.8 Microprocessor 318
A.9 Batteries 318
A.10 Charger Input 319

Appendix B: Operating Environment 321
B.1 Operating Temperature 321
B.2 Humidity 321
B.3 Waterproofing and Dustproofing 321
B.4 Storage Conditions 322
B.5 Electromagnetic Compatibility 323
B.6 Resistance to Shock, Vibration and Impact 323
B.7 Resistance to Pressure and Elevation 323

Appendix C: Character Set 325

Appendix D: Hexadecimal to Decimal Conversion 327

Appendix E: Keyboards 329
E.1 Keyboard layouts 329
E.2 Key matrix codes 332
E.3 Scan codes 333

Appendix F: Interfacing 339
F.1 9-way D type (Port 1) 340

Appendix G: MP2500, FS3 and FS/2 341
G.1 Hardware and user differences 341
Batteries 341
External input voltage (charger input) 341
Power and charging times 342
Rapid Discharge 343
Power save modes 343
Execution speed 344
RTC (real time clock) 344
Formatting the Fixed Disk 344
PC Card support 344

Interrupt-driven polled comms 345
HCOM 345
Ports 345
Keyclick 346
Sounder 346
Operating system 346
RAM backup battery and the MP2500 and FS3 disk 346
Memory 348
Disk compression 348
Peripheral power 348
G.2 BIOS differences 349
INT 10H, screen handler 349
INT 13H, disk services 349
INT 14H, communications 349
INT 15H, BIOS extensions 349
INT 16H, Keyboard services 350
INT 17H, Printer services 350
INT 19H, DOS boot 350
INT 1AH, Clock 350
G.3 Porting FS/2 Applications 351
G.3 Porting FS3 applications to MP2500 353
Hardware differences 353
Software differences 353
Ignored INT 14H functions 355
Ignored INT 15H functions 357
G.4 Power Save Features 364
Introduction 364
Power Saving Features 365
Using the BIOS automatic power saving features 366
Communications and the BIOS automatic power saving features 367
Other situations to look out for 367
Using idle time 368
Conclusion 368

Appendix H: Technical Notes 369

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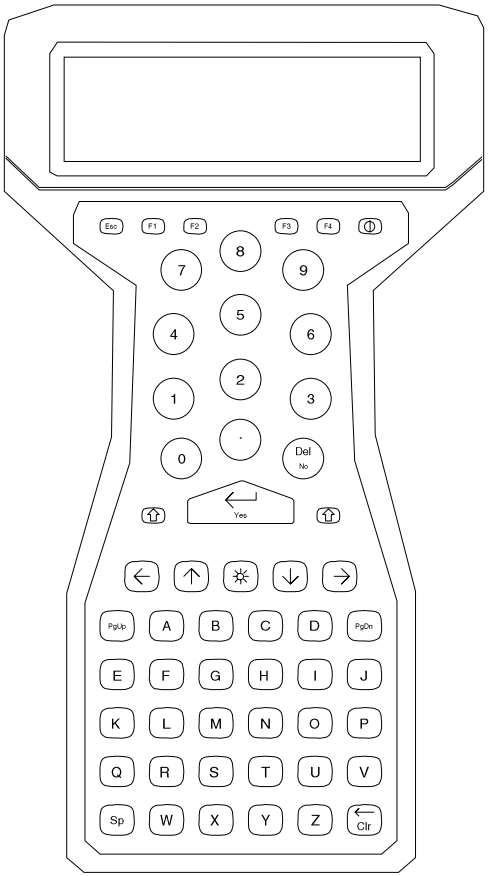
1. Welcome to the HUSKY MP2500

Note: Throughout this publication, the term **HUSKY** is used to mean **WPI HUSKY TECHNOLOGY LTD**. **MP2500** means the **HUSKY MP2500**.



HUSKY TECHNOLOGY's **MP2500** is a small but tough MS-DOS computer.

Resistant to moisture, dust, vibration, shock and electromagnetic interference, it should provide you with long and trouble-free operation.

It is a product of many years' experience developing portable computers. If you have any problems or queries, consult this guide first.

If you need more help, please contact your supplier or Customer Support at **HUSKY**.

The **MP2500** is a practical tool for use in some of the most demanding environments.

CAUTION:	Hazardous voltages inside. Do not attempt to open the **MP2500**. There are no user serviceable parts inside. Opening the case may damage the seals.

1.1 The MP2500 system

The **MP2500** is a complete, ready to use system, consisting of:

- The **MP2500** with its standard software
- A set of alkaline batteries, or a rechargeable battery stick (optional)
- A backstrap
- The *MP2500 User Leaflet*, for end users
- AC adaptor (optional)

1.2 Features

Measuring just 242 x 132 x 44 mm (9.5ins x 5.2ins x 1.7ins) maximum and weighing 680 g (24 oz) with alkaline batteries or 700 g (25 oz) with rechargeable batteries, the **MP2500** is a completely self-contained powerful computer, small enough to hold in one hand and carry all day.

For typical applications, the **MP2500** can operate all day from internal batteries and is sealed against moisture, dust and other hazards, so you can take it with you and use it almost anywhere.

It includes MS-DOS on a non-volatile CompactFlash drive, and (for a low power consumption hand-held computer) the hardware architecture is very PC-compatible. This means that **MP2500** can run a wide range of software.

You can also program the **MP2500** using your usual PC-compatible assembler or compiler. Assembly language access allows full use of its many specialised features.

Data and programs can be exchanged easily with other PC compatible computers by using the built-in communications utility (HCOM).

1.3 Options

The **MP2500** may also be fitted with a number of options, to provide a versatile system. These options include:

- choice of battery type: alkaline non-rechargeable cells, NiCd (Nickel Cadmium) rechargeable battery stick, or high capacity NiMH (Nickel Metal Hydride) rechargeable battery stick
- display backlight
- fully sealed membrane keyboard option (with fluorescent "glow in the dark" overlay option)
- plug-in AC adaptor (charger)
- neck strap

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2. The MP2500 Guides

The standard **MP2500** documentation consists of the following guides:

MP2500 User Leaflet

Tells an operator how to use and look after the **MP2500**. You will also need to tell the operator how to use the application which you install on the **MP2500**.

You may also want to provide the operator with more information (such as how to change batteries), if they have to cope with such situations on their own.

Husky MP2500 System Developer's Guide

Technical information, for the personnel who maintain and develop software for the **MP2500**. It:

- Introduces you to the **MP2500**.
- Explains how to set up, maintain, fault-fix and expand the **MP2500**, including details of commands which are not provided by a desktop MS-DOS computer.
- Provides additional technical information that you will need to write or adapt programs for the **MP2500**, concentrating on details that are different to a desktop MS-DOS computer.

The Husky File Transfer Utility Guide

How to use the **HUSKY** HCOM utility to transfer files between the **MP2500** and a PC compatible.

This is the *MP2500 System Developer's Guide*. Please discard any previous editions of this guide. Always refer to the latest information published by **HUSKY**.

If you already know how to write programs for MS-DOS computers, you need only refer to the *MP2500 System Developer's Guide* (this guide) for a description of the extra facilities provided.

If you require an introduction to using or programming with standard MS-DOS, there are many standard texts available.

2.1 The HUSKY Web Site

For the very latest information, visit the **HUSKY** web site on the Internet, at **`http://www.wpihusky.com`**. This offers useful information, including:

- Technical Support
- FAQs
- Product information
- Bug lists
- Software updates
- Documentation updates
- Complete manuals for many products

3. Using this Guide

3.1 Structure

This guide is divided into four main parts:

Part 1: Introduction	A brief introduction to the **MP2500** and this guide, that you should read first.
Part 2: Setting Up	Details of the commands and operating procedures which you will need to set up and maintain the **MP2500**. If you are not already familiar with MS-DOS you may also need one of the many MS-DOS user guides available.
Part 3: Technical Reference	Technical information for programmers, describing the overall structure, software interrupts available, hardware interrupts used and device emulation's. You should read this in conjunction with an MS-DOS programming guide if you are not already familiar with programming under MS-DOS. You may also need to refer to hardware descriptions (such as *the IBM PC-AT Technical Reference*) if you are not familiar with IBM PC hardware.
Part 4: Appendices	Summary technical data, for ease of reference.

There is also a detailed index, at the end of this guide.

3.2 Suggested reading approach

Whatever your interests, you should start by reading the rest of this part of the guide (*Introduction*). Then:

To learn about:	**See:**
Setting up the **MP2500**	Chapters 5 and 6.
Using and maintaining the **MP2500**	The *MP2500 User Leaflet* and chapters 7 to 9 of this guide.
An introduction to MS-DOS, and MS-DOS commands	A standard MS-DOS user's guide.
The extra **MP2500** commands	Chapters 10 to 12.
Installing an application	Chapter 17 and the application's installation instructions.
Communications	Chapters 13 and 14.
Connecting a peripheral	Chapter 13 and Appendix F.
Writing software for the **MP2500**	Chapters 19 onwards and a standard MS-DOS programmer's guide.
Adapting MS-DOS software for the **MP2500**	Chapter 18.
Batteries, charging, and power management	Chapters 8, 11, and 33.
Optimising software applications for low power consumption	Chapter 33 and Appendix G.
Porting applications from **FS/2** and **FS3**	Appendix G.

3.3 Conventions

Throughout these guides, a few simple conventions are used to help clarify descriptions. These are mainly used to indicate text to type, as follows.

DIR	this is text which should be typed exactly as shown. If you prefer, you may type it as the equivalent small letters (d i r).
filename	this is a description of text to type, rather than the actual characters. In this case, you should type the name of a file (for example, PROGRAM1).
	this is a name or symbol representing the key that you should press or hold down. In most cases, the name or symbol is the same as appears on the key.
[,A]	this is an optional part of the text ie text which may be omitted or typed, depending on what you want to do.
Enter new date	text as it appears on the screen

These conventions are often used in combination. For example:

DIR [*filename***]**	means type D I R and then a space, then either press the key, or type the name of a file and press

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4. Introduction

This part of the guide describes:

- How to unpack, check and set up the **MP2500** to run an application. (Chapter 5.)
- The information and hardware to give to a user. (Chapters 6 and 7.)
- How to keep the **MP2500** running smoothly, including how to diagnose and fix common problems. (Chapters 8 and 9.)
- How to use the special **MP2500** utilities. (Chapters 10 to 12.)
- How to use communications to load applications and data to or from the **MP2500**. (Chapter 13 and 14.)
- The accessories available for the **MP2500**. (Chapter 15)

For information on using standard MS-DOS commands, see any of the standard MS-DOS user's guides. For information on programming the **MP2500**, see Part 3. For information on programming with MS-DOS, see any of the standard MS-DOS programmer's guides.

If you've used a desktop MS-DOS computer before, you'll find using the **MP2500** quite similar, but with a number of important differences. Some are fairly obvious: like the portability, small size and different keyboard layout. Other differences are more subtle but very useful. For example, if you turn off while using an application, when you turn on again the **MP2500** will carry on running the application as if nothing had happened.

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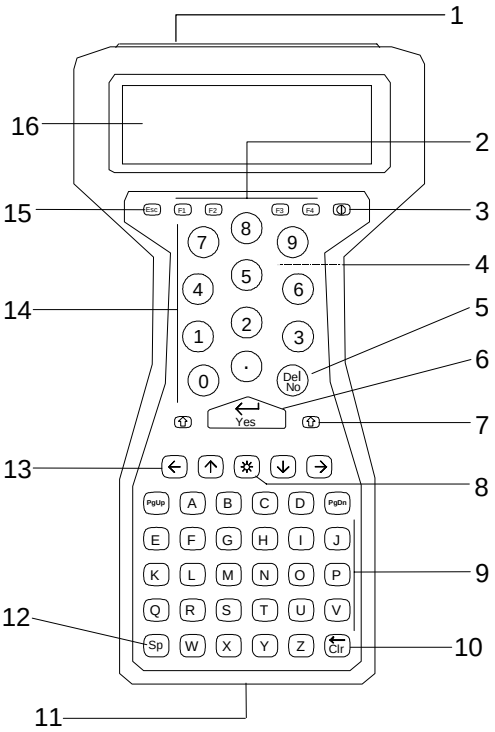
5. Setting Up

This chapter briefly describes how to set up the **MP2500** to run an application. You may also need to refer to Chapter 7 for more details of how to turn on and off, reboot and use the main controls. You will need this information yourself and may need to pass some of it on to the operators using the **MP2500** in the field.

Note: The *MP2500 User Leaflet* is supplied with each MP2500 and provides important user information. We suggest you read the leaflet in conjunction with this section.

5.1 About the MP2500



1. CONNECTOR: main serial communications port (Port 1, COM2) 9 way D-type.

2. FUNCTION KEYS: press to use application functions.

3. POWER KEY: press to turn on or off.

4. HANDSTRAP: on the rear of the unit, this helps you hold the **MP2500** securely.

5. DEL/NO KEY: press to delete entries or answer No to a question.

6. ENTER/YES KEY: press to complete typing, type a carriage return, or answer Yes to a question.

7. SHIFT KEYS (⇧): hold either down to type the characters (or functions) shown above the keys.

8. BACKLIGHT KEY: if backlight ***option*** is fitted, press to illuminate the screen for use in low light. You may need to press **L** at the same time, depending on how your **MP2500** is set up. This key can also be configured (under software control) as the **HUSKY** "PAW" key, which provides access to a range of special functions.

9. TYPING KEYS: type letters, or symbols and functions when used with ⇧ (SHIFT).

10. BACKSPACE KEY: press to erase typing.

11. BATTERY CAP: remove to change batteries.

12. SPACE KEY: types a space (blank) character.

13. CURSOR KEYS: move the cursor.
    SHIFT ↑ and SHIFT ↓ adjust screen contrast.

14. NUMERIC KEYPAD: type numbers.

15. ESCAPE KEY: usually used to cancel a function.

16. LCD SCREEN: displays prompts and messages and information as you type.

Note: **MP2500** is normally shipped with the ☼, PgUp and PgDn keys configured to operate as PAW, CTRL and ALT.

5.2 Fitting batteries

MP2500 is normally supplied without any battery fitted, you should therefore fit batteries before use. If you are using NiMH or NiCd batteries you must only use the appropriate **HUSKY Battery Stick** (or **HUSKY**-approved alternative). See section 8.2.2 for information on setting up for rechargeable batteries. If fitting alkaline batteries, you will need three AA-size alkaline batteries and the battery packing tube supplied with **MP2500** (this packing tube is only supplied if alkaline batteries were specified at the time of the order).

CAUTION: Do not mix batteries of different types, sizes, or states of charge. DO NOT FIT LITHIUM BATTERIES UNDER ANY CIRCUMSTANCES.

Alkaline batteries are not suitable for operation of high power PC Cards and peripherals, or for use at low temperatures.

We do not recommend use of the cheaper Zinc-Carbon batteries for routine operation, as they may leak (damaging the **MP2500**) and have shorter lives. You may however use such batteries for short periods, in an emergency.

To fit the batteries:

- **Turn off**.
- Use a COIN to undo the battery cap.
- Carefully feed in the battery stick (or individual alkaline cells), **positive end first**. If you are fitting AA-size batteries, insert them in the battery packing tube.
- Take the battery cap and, with finger pressure only, press it into the battery compartment and turn it clockwise.
- Only after the thread is started, use a coin to screw the cap tightly home.

If you prefer, you can operate the **MP2500** from the **MP2500 AC Adaptor** when portability is not required, provided that the unit is fitted with rechargeable batteries. See section 8.2.4 for details.

If the **MP2500** has been delivered from the factory, or stored without any batteries for a long period, the internal backup battery will be flat. The **MP2500** can still be used (by fitting a main battery or connecting the **MP2500 AC Adaptor**), but RAM contents may not be retained if the power source is removed. The backup battery will begin trickle charging when you fit batteries and execute software programs, but may take a long time to charge completely. To fully recharge the backup battery, ensure alkaline batteries are **NOT** fitted and connect the AC Adaptor. Leave it on charge for a total of 72 Hours (e.g. for 5 overnight charging sessions).

One overnight charging session normally provides sufficient initial backup for typical use.

5.3 Turning on

To turn on, press the ⓘ POWER key firmly.

If the unit does not power on, it is necessary to perform a 'hard' reset. Press and hold down both ⇧ (SHIFT) keys, then also hold down the ⓘ (POWER) key for at least 5 seconds. Release all three keys and after a brief delay the **MP2500** should start, by sounding a beep and displaying the Welcome screen (or other screen, depending on the **MP2500**'s configuration).

Follow any instructions displayed on the screen.

5.3.1 Turning on for the first time

If you are turning on for the first time you should see a screen like this:

This is the 'Welcome' screen, which shows that the **MP2500** is starting up for the first time (or has been reset). Press any of the 'normal' keys (such as A or ↵) to load MS-DOS. This is also known as a 'cold start'.

Note that the Welcome screen can be disabled. If it is, the MS-DOS prompt will be displayed instead, without having to press any keys first.

If there is no AUTOEXEC.BAT file, MS-DOS will prompt you for the date and time, by displaying a prompt like this:

```
Current date is Tue 1-01-1980
Enter new date (mm-dd-yy):
```

Type the date in the indicated format and press ⏎ and you will be prompted for the time, something like this:

```
Current time is  0:00:01.00
Enter new time:
```

Type the time now (in the format hh:mm or hh:mm:ss, 24 hour clock) and press ⏎.

If you are not going to set up now, turn off by pressing ⏻ again, to conserve power.

5.3.2 Turning on at other times

Normally, when you turn on the **MP2500** will continue with what it was doing when last turned off, as if you had never turned off. This is quite unlike a conventional desktop computer, which reboots each time it is turned on.

If you cannot see anything on the screen, you may need to adjust the screen contrast. This is particularly likely if the **MP2500** has previously been used in much warmer or colder conditions. Hold down the ⇧ key and press ↑ or ↓ until the screen is clearly visible. If this does not help, the batteries may be run down, or there may be something wrong with the **MP2500**: see Chapter 9.

5.4 Configuring the MP2500

5.4.1 Power management

This introductory section provides an overview of **MP2500** power management. For full details of setting up, refer to Section 8.2

The **MP2500** provides a single power management mode, which is based on the **HUSKY FS3** Standard Power Management (SPM) mode.

The **MP2500** monitors the battery voltage level, and if this drops below a threshold, it displays low power warning messages and turns off to conserve the remaining power. Charging can be enabled or disabled. If a charger is connected with charging enabled, the batteries will charge at a fixed rate. After 20 hours of continuous charging the **MP2500** will timeout and switch to a trickle charge rate.

If the battery level falls so low as to endanger the processing and memory contents, the **MP2500** hardware will turn off (without displaying a warning message).

The **MP2500** is normally supplied without batteries installed, and with charging disabled.

To change the power charging settings, see section 8.2 (unless the application does this for you). For further background on power monitoring, see section 8.2.5.

5.4.2 Time and date

If you got the time or date wrong when you turned on for the first time, you can correct them by using the TIME or DATE commands (see your MS-DOS manual), or by using the system utility UTIL (see sections 10.1.2 and 10.1.3).

5.4.3 Serial port

If you are going to use the serial port (e.g. to load the application from a desktop PC), set it up to suit the connected device, as described in Chapters 13 and 14. (If an application is going to use the serial port, it should set it up itself.)

5.4.4 System files

Just like any MS-DOS computer, many aspects of operation of the **MP2500** can be configured by creating (or editing) text files called CONFIG.SYS and AUTOEXEC.BAT (in the root directory of drive C) and rebooting.

The easiest way to create or edit these files is to use the built-in text editor ED (see Chapter 12) or to create the files on a PC and download them to the **MP2500** (see Chapter 14).

The **MP2500** does not have any special requirements in this area, so simply create files the way you would on any PC. You may however prefer to use a small value for BUFFERS, since the **MP2500** disk is fast enough not to need additional buffering.

One of the **MP2500**-specific commands you may want to include in AUTOEXEC.BAT is the **HUSKY** International Keyboard Program, I.EXE, described in the next section.

CAUTION: Do NOT run KEYB.COM or include a KEYB command in AUTOEXEC.BAT! Use I.EXE if you require support for a non-English keyboard.

5.4.5 International keyboards

MP2500 is available with a number of different keyboard layouts to cater for different requirements. Support for non-English keyboard layouts is provided by a simple utility called I.EXE.

To use I.EXE, simply type **I** and press ⏎. This will display a menu like this:

```
Version x.x
WPI Husky International Keyboard Program
Select option number to install :-
   0 (Reset)  1 (German)  2 (Swedish)
   3 (Danish) 4 (TDS)
Or any other key to abort
```

Press the number key which corresponds to the unit's keyboard layout, or any other key to quit without changing the keyboard. **0** resets the keyboard definition to the default (American English). The keyboard redefinition happens immediately and will remain in force until the **MP2500** is rebooted.

To make the keyboard definition "permanent", add a command to AUTOEXEC.BAT to run I.EXE with the appropriate number. For example, to select a Danish keyboard layout, add **I 3**.

CAUTION: Do NOT use KEYB.COM to provide support for a non-English keyboard. Use I.EXE!

5.5 Non-volatile configuration

Using the UTIL utility, you can configure the following aspects of a unit:

- Enable or disable the Welcome screen.
- Enable or disable backlight resume mode (if this option is fitted).
- Change its serial number.
- Change its oem id.
- Rechargeable battery type selection of either NiMH or NiCd type.

For details, see section 10.1.5, Communication Port Setup, and section 10.1.7, *Command line switches*.

5.5.1 Rebooting

To reboot, hold down Ctrl (default legend: PgUp) and Alt (default legend: PgDn) and press Del simultaneously, then release all three keys. Normally, the Welcome message will be displayed; press any normal key (eg ↵) and the DOS prompt should be displayed (or a date prompt, if there is no AUTOEXEC.BAT file). You are now ready to install the application.

5.6 Installing the application

5.6.1 Copying the files

While you *can* develop applications on the **MP2500**, they will typically be developed and stored on a desktop PC, or provided on a PC-compatible diskette.

To use an application on the **MP2500**, copy the application program and data files from the PC to an appropriate directory on the **MP2500** C drive. Copy the file by using the supplied communications utilities (HCOM or XL - see Chapter 14) or by using the MSDOS INTERLINK utility (see section 10.5).

5.6.2 Setting up the application

If you created a new directory for the application, operation will probably be simpler if you add that directory to the PATH statement in AUTOEXEC.BAT.

If the application requires changes to CONFIG.SYS or AUTOEXEC.BAT, make them now (see section 5.4.4) and then reboot to bring the changes into effect. For example, the application might require a higher FILES figure (CONFIG.SYS) or be designed to run from AUTOEXEC.BAT.

5.6.3 Running the application

As a final step, make sure that the application runs correctly!

If it does not, find out what is stopping it. To exit the application or reboot you may need to use emergency breakout or a hard reset (see section 9.2), as some applications will disable Ctrl+Alt+Del reboot.

5.6.4 Default files shipped with MP2500

MP2500 uses non-volatile CompactFlash (CF) as drive C. It is configured as a non-removable hard disk. The following default files are present when the unit is shipped:

```
C:\

IO.SYS              hidden, system
MSDOS.SYS           hidden, system
AUTOEXEC.BAT
COMMAND.COM
CONFIG.SYS
ED.COM              text editor
HCOM.COM            Husky file transfer utility
PCOM.COM            BIOS download utility
UTIL.COM            MP2500 configuration utility
XL.COM              Xmodem loader
NMIEN.COM           (may or may not be included,
                     depending on the configuration)
I.EXE               international keyboard driver

DOS subdirectory
C:\DOS\

HIMEM.SYS           XMS driver
DEBUG.EXE           DOS debugger
DOSKEY.COM          keyboard utility
INTERLNK.EXE        DOS external drive mapper
INTERSVR.EXE        DOS external drive mapper - server
```

The following files are also included in the DOS subdirectory from early 1999 onwards:

```
FORMAT.COM          formats the disk
XCOPY.EXE           copies files, directories and
                    directory trees
ATTRIB.EXE          sets file attributes
```

All these files are read-only with the exception of AUTOEXEC.BAT and CONFIG.SYS. The files use approximately 430k of disk space.

5.6.5 Year 2000 compliance

MP2500 is designed to be compliant with the Year 2000 changeover:

- The **MP2500** CMOS maintains a century byte.
- **MP2500** has been tested to confirm correct operation at the year 2000 roll-over, and correct interpretation of leap years.

Note: Although the BIOS returns the year value in full, it is the application's responsibility to use the 4-digit value correctly.

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6. Issuing the Unit

Once you are satisfied that the **MP2500** and installed application work correctly, you can give the unit to its intended user. Most applications are designed to 'lock in' the user ie to prevent the user exiting the application and deny them access to facilities which they do not need. Before issuing the **MP2500**, make sure that it is set up correctly and that the application is running.

You may also want to provide other items, such as:

- The *MP2500 User Leaflet*, which describes how to operate the **MP2500**.
- Instructions (or training) on using the application that you have installed.
- Spare batteries.
- The **MP2500 AC Adaptor**, if you have fitted rechargeable batteries. **Warn the user not to attempt to use the adaptor if they fit non-rechargeable batteries.**
- Accessories, such as a neck strap.

Make sure that the battery cap is tight, to avoid the ingress of dust or damp.

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7. Using the MP2500

This chapter describes in detail how to operate the **MP2500** ie how to use the keyboard, screen, and main controls. This information is more detailed than that in the **MP2500** User Leaflet, with emphasis on the default (developer) keyboard, and the DOS environment. It is mainly intended to help you set up and maintain units, but may also help you to help users who need more guidance.

7.1 Turning on and off

To turn on, press ⏻ and the **MP2500** should turn on, beep, and carry on execution from where it was turned off. If it will not turn on, check the screen contrast (see section 7.3.2) and batteries.

To turn off, press the ⏻ key firmly. You should turn off whenever you are not going to be using the **MP2500**, even if it's just for a few minutes, as this will help extend battery life.

The **MP2500** will also turn itself off, if:

- the battery power is low, OR
- you haven't touched any of the keys for a while and it is not using its serial port, OR
- an application is running which tells it to turn off

You can just turn on again and carry on working as if nothing had happened, when you want.

7.2 Rebooting

As already mentioned, the **MP2500** does not reboot each time it is turned on, but continues execution from the point where it was turned off. This makes operation very convenient, but there will be times when you want to reboot. For example, if you change C:\CONFIG.SYS (eg add a device driver), you must reboot to bring the changes into effect.

To reboot, press Ctrl+Alt+Del. This displays the 'Welcome' screen:

Press any of the 'normal' keys (such as ⏎) and the **MP2500** will perform a normal MS-DOS boot, configuring the system as specified by the CONFIG.SYS file and executing the commands in the AUTOEXEC.BAT file (in the root directory of drive C). Note execution of the AUTOEXEC.BAT and CONFIG.SYS can be avoided by holding down the ⇧ (LEFT-SHIFT) key.

If an application has disabled Ctrl+Alt+Del, you cannot reboot in this way and must instead use the emergency breakout method, described in Chapter 9.

Depending on how the **MP2500** is set up, this may start an application automatically, or take you to MS-DOS command mode, for you to use MS-DOS commands or run applications by typing the appropriate commands. (If you want to leave the application, you should have been provided with instructions on how to do this. If not, see Chapter 9.)

7.3 The screen

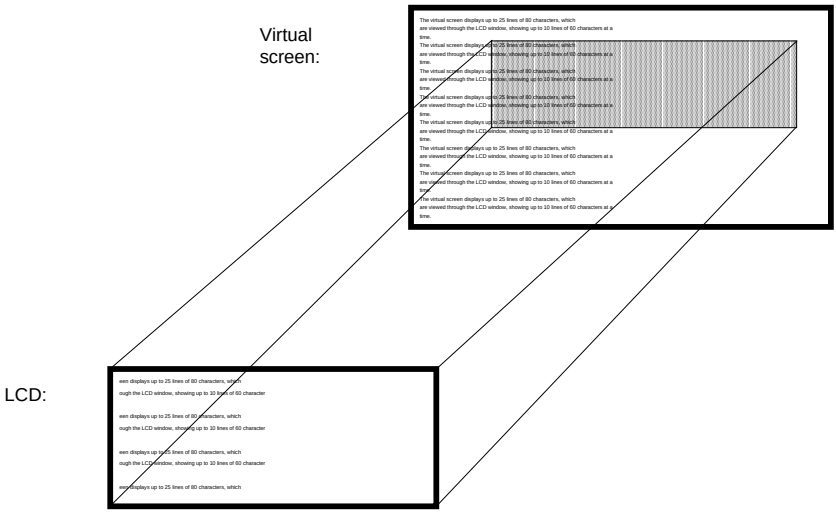
7.3.1 Introduction

The **MP2500** has a large LCD (liquid crystal display) screen, which can show up to 10 lines of 60 characters and pictures using a grid of 240 by 64 dots.

The screen is protected by a tough, scratch-resistant plastic window. However, it can be scratched if mistreated, so please take care.

Because the LCD display works by contrast, rather than by emitting its own light, it is perfectly visible no matter how bright the light is. In bad light, the backlight provides excellent visibility.

The screen behaves as a ‘window’ onto a larger ‘virtual’ screen, which emulates the IBM CGA (colour graphics display adaptor) ie provides 25 lines of 40 or 80 characters (text modes) or 320x200 or 640x200 pixels (graphics modes). (For more detailed information, see Part 3.)



Applications can use the display exactly as if it were a full size IBM CGA screen. The LCD screen ‘window’ moves over the virtual screen automatically, to show the most recent output (eg a prompt waiting for input, or your typing). You may also control it by using special keys (see section 7.3).

7.3.2 Visibility

The LCD screen gives good results in most lighting conditions. For use in poor light, an ***optional*** backlight can be specified.

To adjust the LCD screen for maximum clarity, place it at the angle you will be working, then:

- Hold down either ⇧ key and press ↑ or ↓. Release both keys when the display appears clearest.

To improve visibility in bad light, turn on the optional backlight, if fitted:

- If you are using the default keyboard (see section 7.4.3), hold down the 🐾 key and press L

- If you are using the user keyboard (see section 7.4.3), press ☼

To turn the backlight off, press the same key(s) again. The backlight places an additional drain on the batteries, so only use it for short periods.

To maintain legibility, wipe the screen with a clean cloth. Do not use solvents or abrasives as they might damage the screen. Do not leave the screen in bright sunlight for long periods, particularly inside a vehicle.

7.3.3 Moving around the virtual screen

The virtual screen provides a CGA-compatible screen, allowing up to 25 lines of 80 characters and graphics with resolutions up to 640x200 pixels. The LCD provides a window onto this virtual screen, which can display up to 10 lines of 60 characters, or 240x64 pixels.

The window moves over the virtual screen automatically to show the most recent keyboard input. If you are using the default keyboard, you can also move the window manually, by pressing the 'viewing keys':

- To flip the window to show the other side of the virtual screen, hold down the 🐾 key and press F. (This is the LCD flip key.)

- To move the window a line or column at a time, hold down 🐾 and press one of the cursor keys. (These are the LCD looking keys.)

If you are using the user keyboard, use the cursor keys as LCD looking keys.

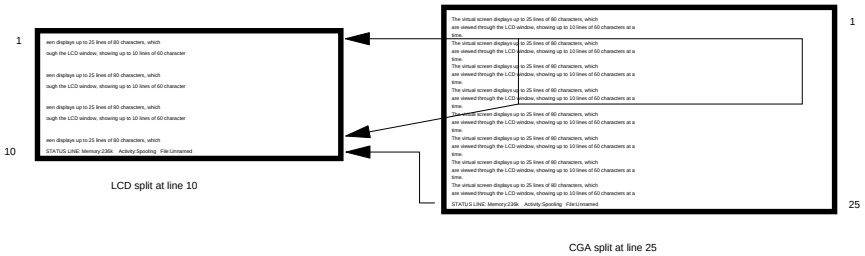
The window will return to its original position as soon as you type something.

7.3.4 Split screen

Many standard applications use a particular screen line (usually the top or bottom line) for status information and the rest for the information which is being entered or displayed. As the LCD screen shows whichever part of the full screen is being updated, this could lead to a lot of distracting screen movement.

To help prevent this, you can split the virtual screen into two parts, and display each in a separate part of the LCD screen. Each part of the LCD can either be fixed in position or scrolled to show output in the corresponding part of the virtual screen.

For example, if your application uses line 25 as a status line, you could split the virtual screen at line 25, and split the LCD screen at line 10. Ensure screen font mode is 6 x 4:



The top nine lines of the LCD could be set to scroll (to show data input/output), while the bottom line could be set to fixed (to show the status line).

To do this, press the HOT key (🐾H), and you'll see a screen like this:

The last line of the screen indicates the keys you can use. The current selection (**Screen**) is highlighted (in reverse).

If the **Screen** option is not highlighted, move to it by using the ← or → key. Press ↵ to select it and you'll see a screen like this:

Screen Parameters
Text font size: 8x6
Inverse video: Background
Split screen: No Scrollable -
Physical Row: 01 Top: Yes
Logical Row: 01 Bottom: No
Screen with cursor synchronisation: Yes
↔-move ↑↓-change ↵-accept Esc-quit

Move the highlight to the options you want to change by using the ← and → keys, then adjust the display value by pressing ↑ or ↓ key. The 'physical row' is the row at which to split the LCD. The 'logical row' is the row at which to split the CGA. When the screen is split as you want it, press ↵ and then Esc to leave the HOT key.

7.3.5 Inverse video

The IBM CGA screen (which the **MP2500** emulates) can display text with a wide range of attributes, including foreground (text) colour (red/green/blue) and intensity, background colour (red/green/blue) and blinking. These attributes are typically used to highlight options or important messages, or for purely decorative purposes.

The **MP2500** screen is monochrome and cannot display colours. It can however display text as reverse video (white on a black background) and you can choose to use this to emulate some of the other text attributes.

To change the way reverse video is used, select the default keyboard and press the HOT key (H), make sure the highlight is on the **Screen** option (if not, use ← or → to put it there), then press ↵. You'll see a screen like this:

Screen Parameters
Text font size: 8x6
Inverse video: Background
Split screen: No Scrollable -
Physical Row: 01 Top: Yes
Logical Row: 01 Bottom: No
Screen with cursor synchronisation: Yes
↔-move ↑↓-change ↵-accept Esc-quit

Move the highlight to the **Inverse video** option with the ← and → keys, then adjust the displayed value by pressing the ↑ or ↓ key. The options are as follows:

Background Use inverse video for text with a background colour other than black.

Intensity Use inverse video for high intensity (bright) text.

High Back Use inverse video for text with a high intensity (bright) background.

Int/Backgd Use inverse video for text with a high intensity (bright) text or background.

None Do not use inverse video.

Monochrome Use inverse video for text with a black foreground and a white background (as on an IBM monochrome display adaptor).

When you've set inverse video as you want it, press ⇦ and then Esc to leave the HOT key.

If you have problems reading the screen, try changing the inverse video method to get the best effect.

7.4 The keyboard

7.4.1 Introduction

The keyboard is used for typing and to control the **MP2500**.

Typing is provided by letter keys organised in an alphabetical layout, with separate numeric keypad and cursor key clusters. Symbols and punctuation are provided by SHIFT (⇧) plus letter keys. This provides access to all the functions that you are likely to need, although applications can also redefine any of the keys to provide access to other functions, if required.

7.4.2 Keyboard options

The standard keyboard uses individual, hinged moving keys. This provides excellent feel, but can degrade due to the ingress of dust or liquid contamination.

A fully sealed flat membrane keyboard is available as an option. This has tactile "click" action and a customisable legend overlay. The flat keyboard is also offered with a "glow-in-the-dark" overlay. This stores energy when exposed to the light which makes it visible for several minutes in the dark.

7.4.3 Keyboard modes

Three keys on the keyboard can operate in two different modes:

Key legend	**mode 1 (default)** **Developer mode**	**mode 2** **User mode**
☼	PAW key	Controls backlight
PgUp	Ctrl	PgUp
PgDn	Alt	PgDn

The keyboard is initially in mode 1 (developer mode), but you can switch between the two modes at any time by holding down both ⇧ keys and pressing the key immediately above ⇦ (usually ⊙).

The Ctrl and Alt keys are used as on a normal PC compatible keyboard. The PAW key (❀) provides special control functions for the display, backlight, sound and other facilities. An application will normally lock the keyboard into mode 2 (user mode); if users require access to these functions, the application can provide this via extended BIOS calls described in Part 3.

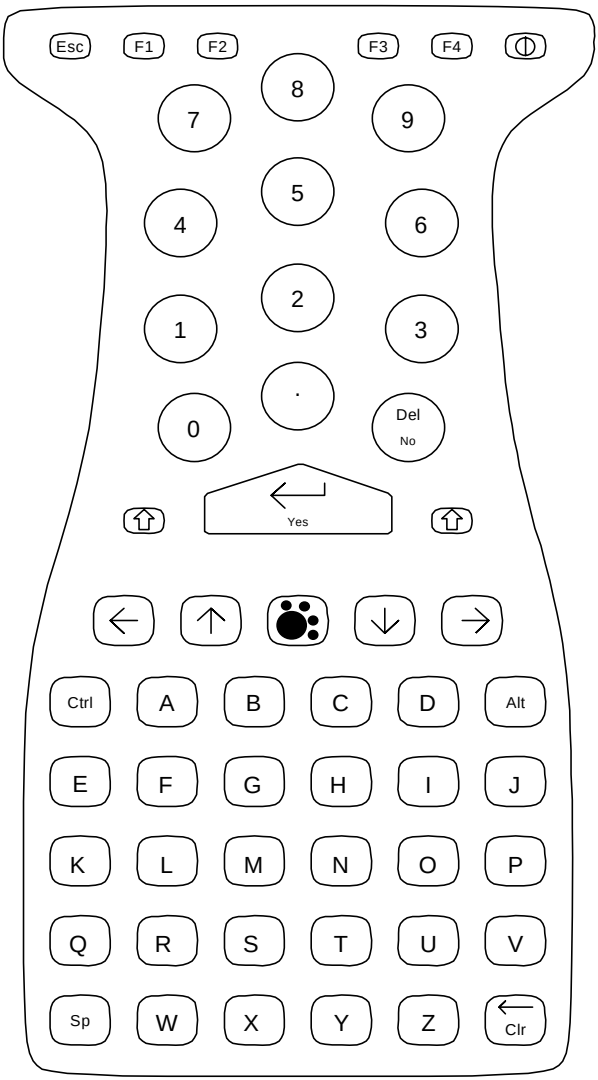
Note: This manual generally assumes that the keyboard is in Mode 1 (default), unless stated otherwise. The following pages show the **Mode 1 (default)** keyboard layout.

For pictures of the **Mode 2 (User)** keyboard layout, please refer to Appendix E.

See also *International keyboards*, section 5.4.5.

7.4.4 Normal keys (default keyboard mode)

The keyboard functions like this (in unshifted mode):

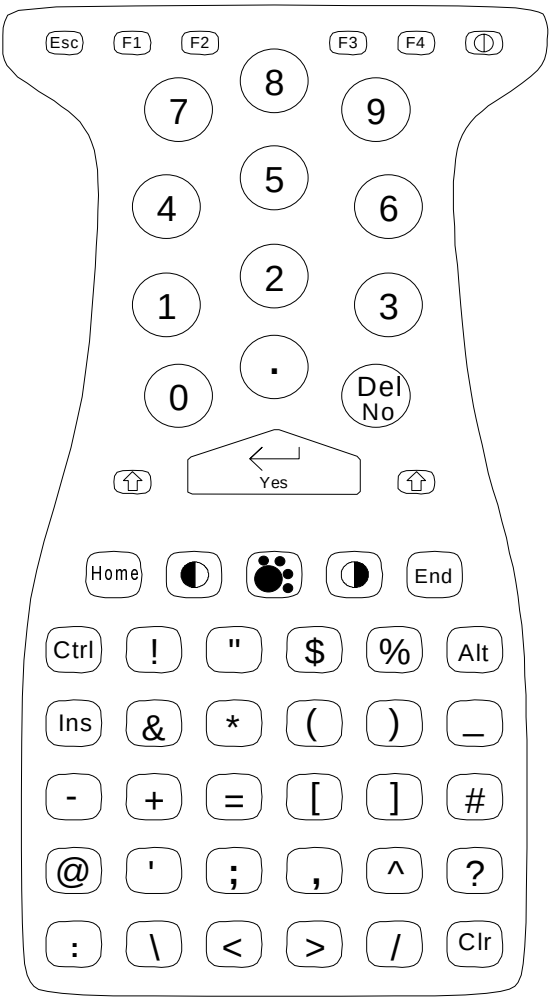


Note that the letter keys type lowercase letters. To type capitals, select CAPS LOCK mode (press C).

7.4.5 Shifted keys (default keyboard mode)

When used with either of the ⇧ (Shift) keys, the main keys function as follows:

Note that the numeric keypad is normally unaffected by Shift.



7.4.6 Special keys

Certain other keys must be typed as key combinations, using the special 🐾 key:

For:	Type:
F1..F10	🐾 plus the function key number. Use 0 for **F10**
Scroll Lock	🐾Esc
Ctrl-Break	Ctrl🐾Esc
keypad *****	🐾P
Print Screen	⇧🐾P
Caps Lock	🐾C

The 🐾 key also provides access to a number of control functions, as follows:

To:	Press:
Shift window left	🐾←
Shift window right	🐾→
Shift window up	🐾↑
Shift window down	🐾↓
Flip window	🐾F
Increase contrast	🐾E
Decrease contrast	🐾X
Turn backlight on/off	🐾L (if option fitted)

Toggle keyclick volume 🐾Y

Sound on/off 🐾S

HOT key 🐾H

The screen control keys have already been described in section 7.3.

The HOT (or status) key is used to display and optionally alter aspects of the **MP2500** set-up. When you press this key combination, the screen displays the following information:

- The time and date.
- The state of the CAPS LOCK function. (On **MP2500**, NumLock is always off.)

To return to the normal screen display, press Esc or press 🐾H again.

This key also allows you to adjust the screen, keyboard and power settings. For full details, see Chapter 11.

7.5 Using MS-DOS

The **MP2500** operating system is the industry-standard for desktop computers, Microsoft's MS-DOS. The version used is 6.22.

If you are not already familiar with using MS-DOS, you should consult any of the standard MS-DOS user's guides for an introduction to and details of the standard facilities and commands.

For details of the MS-DOS utilities, see any of the standard MS-DOS user guides.

The following special **MP2500** utilities are also provided as (read-only) files in the C:\ directory:

ED	A simple text editor
HCOM	Versatile file transfer utility
UTIL	Set time/date Format diskette Configure communications Configure non-volatile options
XL	File loader utility with XMODEM protocol built in

If you want to use these utilities, you may need to add their directory (C:\) to your DOS search path.

The **HUSKY** communications utility, HCOM, is supplied on an MS-DOS disk for use on a desktop PC.

There is also a status/set up function, accessed via a HOT key.

HCOM, XL, ED, UTIL and the HOT key are all described in more detail later in this guide. For information on:

- HCOM, see section 14.5.
- XL, see section 14.6.
- ED, see Chapter 12.
- UTIL, see section 10.1.
- The HOT key, see Chapter 11.

If any other commands, utilities and applications have been installed by your technical support team for you to use, refer to the instructions which they should also have supplied.

7.6 EMC legislation

To ensure compliance with EMC legislation:

- Use only the approved **HUSKY MP2500** AC Adaptor.
- All communications cables must be shielded. Use **HUSKY** approved cables.
- The maximum system configuration may be limited by local EMC regulations. Consult your system supplier for advice.
- The **MP2500** must only be used with approved peripherals.
- Changes or modifications could void the user's authority to operate the equipment.

For additional advice, refer to the information at the front of this manual (pages ii-vii).

8. Regular Maintenance

Once you have issued a unit to an operator, you will probably see it at regular intervals e.g. to charge the batteries, load revised applications or data, or retrieve data from the unit (see Chapter 14). This will give you the opportunity to carry out quick checks and maintenance steps on a regular basis.

This chapter summarises the main steps that you should take to make sure that the **MP2500** continues to provide trouble-free operation. The next chapter describes what to do if problems do arise.

8.1 Routine maintenance and checks

The **MP2500** needs very little routine maintenance:

- Check the internal humidity indicator, which is visible through a small hole in the bottom right corner of the display window. If this takes on a pinkish colour, remove the internal batteries and return the unit at once to **HUSKY** (or their local agents) to avoid corrosion of internal parts.

- Recharge or replace batteries at regular intervals, as described in section 8.2.

- Clean the display screen and case with a clean cloth.

- If the unit is very dirty, clean it as follows:

- Make sure that the battery cap is tight and that the sealing washer is in good condition. If it has been dropped, check that the case and seals are intact.

- Gently rinse the unit under clean running water (no more than hand hot, 40°C, 105°F). Do not immerse the unit unnecessarily, or use a high pressure jet.

- To remove stubborn deposits, use a soft bristle brush and a mild detergent or soap. TREAT THE KEYBOARD GENTLY. A low pressure water jet or running tap may help to clean debris from the keyboard.

CAUTION: Do not use organic solvents or harsh detergents, as they may damage the casing. To remove stubborn deposits, you should use a mild detergent.

- Blow any water out of the connectors, then leave it to drain and air dry, or use a hair dryer on a low temperature setting (less than 55°C, 130°F). DO NOT EXPOSE THE UNIT TO TEMPERATURES ABOVE 55°C (130°F).

- Finally, polish the screen with a clean cloth.

- The battery cap uses a rubber washer for case sealing. Make sure that the cap is kept tight.

- If fitted, check any straps for signs of wear and replace them if failure is likely, to minimise the risk of the **MP2500** being dropped in use.

8.2 Power

CAUTION: If you change from rechargeable to non-rechargeable batteries, warn anyone you give the unit to. Non-rechargeable batteries must NOT be recharged. Always use batteries of the same type and charge state - don't mix fresh batteries with used batteries, or rechargeable batteries with non-rechargeable ones. Observe the instructions printed on the battery. Replace only with batteries approved by your **MP2500** supplier. DO NOT FIT LITHIUM BATTERIES.

ATTENTION: Dispose of or recycle used batteries according to the manufacturer's instructions. Nickel-Cadmium rechargeable batteries must be recycled, or disposed of properly. (Refer to pages iv and v at the front of this manual.)

CAUTION: BATTERY CHEMICAL LEAKAGE IS CORROSIVE. In the unlikely event of battery leakage, do not touch. In case of accidental contact, flush immediately with running water.

8.2.1 Introduction

The **MP2500** can be operated from different power sources:

1. Rechargeable **HUSKY** NiCd battery stick

2. Rechargeable **HUSKY** NiMH battery stick

3. Alkaline batteries

4. The **MP2500** AC Adaptor

This ability to switch between these power sources provides unrivalled convenience for users. For example, you can power the **MP2500** from the AC adaptor while in the office and fit it with rechargeable batteries for use while on the move. If a user forgets (or is unable) to recharge the batteries while away from the office, they can substitute easily obtainable alkaline batteries if required.

While NiCd and NiMH batteries can be recharged using the AC adaptor, alkaline batteries must not. To minimise the risk of attempting to recharge alkaline batteries, the **MP2500** can be set up to disable charging.

To increase battery life, special low power components and an automatic power-saving system are used. Power monitoring and warning systems are provided to keep you informed.

To protect the contents of the RAM, a trickle-charged internal battery is fitted, which provides sufficient backup power to preserve the contents for 12 to 18 hours at 20°C (68°F), if the main battery is removed or becomes discharged.

The RTC (calendar/clock) is further supported for several years by its own separate backup battery.

Note: For detailed background information on the power management system, see section 8.2.5. For more technical information, including typical power usage figures, see the sections on using power handling in Chapter 33 and the tables in Appendix G.

8.2.2 Using rechargeable batteries

THESE INSTRUCTIONS RELATE TO PERSONNEL SAFETY AS WELL AS RELIABLE OPERATION OF THE MP2500 AND AC ADAPTOR. IT IS IMPORTANT THAT THEY ARE READ AND UNDERSTOOD.

CAUTION: ALSO REFER TO THE PRECAUTIONS AT THE FRONT OF THIS MANUAL (page v) AND ANY OTHER DOCUMENTATION SUPPLIED WITH THE AC ADAPTOR BEFORE USING IT.

We strongly recommend that you use the **MP2500 Battery Stick** or **HUSKY**-approved replacement batteries only.

The batteries can be recharged by connecting the supplied AC adaptor. Note that charging is disabled when operating at extremes of temperature outside 0°C (32°F) to 40°C (104°F) (nominal).

Recharging takes longer at higher temperatures, and therefore the batteries may not receive a full charge.

8.2.2.1 When to recharge

Rechargeable batteries **typically** provide between 10 and 24 hours' operation (depending on use) when fully charged, so you should normally recharge them before each working day (e.g. overnight) to maintain maximum operating time. You should also recharge the batteries if:

- The following message is displayed every few seconds:

  WARNING BATTERIES ARE LOW

- A message is displayed by the application to indicate power is low.
- The **MP2500** will not power up.
- You know that the batteries won't last the next working.
- The batteries haven't been recharged for several weeks. Rechargeable batteries self-discharge, especially at elevated temperatures, so even if

the **MP2500** has simply been stored without being used, it may need recharging after two to three weeks.

If you need to use the **MP2500** immediately, you can change the batteries or use the **MP2500 AC Adaptor**. If you change to non-rechargeable batteries, you MUST disable charging; refer to sections 8.2.3 and 11.5 for details.

8.2.2.2 Recharging batteries

You can recharge the batteries by connecting the **MP2500 AC Adaptor**, with charging enabled.

The special **MP2500 AC Adaptor** is the only AC adaptor which may be used to recharge the **HUSKY** NiMH or NiCd batteries when they are installed in the **MP2500**. Using a non-approved AC adaptor or battery eliminator may damage the **MP2500** or the batteries.

Make sure that charging is enabled. You can now simply leave the unit to recharge, and don't need to do anything else. The charge period is monitored by the operating system, which automatically switches to trickle charge after 20 hours. This allows both NiCd and NiMH batteries to be safely left on charge for long periods. (However, the application may disable charging. If in doubt, check the application's user instructions.)

When using the AC adaptor be absolutely certain that the **MP2500** has the appropriate **HUSKY** rechargeable battery present. Do not even mix rechargeable batteries of different age or state of charge, as this produces a risk of chemical leakage, gassing or explosion. Do not attempt charging at temperatures outside the range 0°C to 40°C, 32°F to 104°F (nominal).

The AC adaptor contains lethal voltages, so under no circumstances should it be opened, in any way tampered with, or used for any other purpose. Keep it dry. There are no user serviceable items inside the case.

The AC adaptor is fully protected against continuous short circuits and is double insulated, so an earth connection is not necessary.

Important Note: During charging, the **MP2500** may heat up noticeably. This is quite normal and does not pose a hazard. In particular, the battery cap and adjacent blanking plug will feel quit warm to the touch.

Procedure

To recharge using the AC adaptor the following procedure is recommended:

1. Switch off the **MP2500**.
2. Plug the AC adaptor into the **MP2500** 9 way D-type connector. Push the plug in until the outer sleeve is flush with the casing.
3. Plug the AC adaptor into the AC outlet.
4. Switch on the AC outlet.
5. Charging should begin, indicated by the screen displaying the message **`Charging in progress`**. (If it does not, make sure that charging is enabled - see section 11.5.) Wait for the batteries to charge fully.
6. If convenient, you may leave the batteries to charge overnight. You may also disconnect the AC adaptor before the batteries are fully charged if you need to.
7. When charging is finished, turn off or disconnect at the AC outlet, then disconnect the AC adaptor from the **MP2500**.

You may turn on and use the **MP2500** even during charging.

As with all electrical apparatus, the AC adaptor should be disconnected from the AC outlet when not in use. Only 240V AC (220 to 250V), 50 or 60 Hz is suitable for standard units. AC adaptors for alternative supplies, such as 110V, are available.

If batteries will not recharge

Your application may have disabled charging. Read your application's user instructions to see how to enable charging.

To check, use the HOT key: press 🐾H, select the **`Power`** option, then press ⏎:

- If **`Battery Charging Support`** is set to **`Disabled`** press → to move to it and press ↑ to change it to **`Enabled`** and accept the change by pressing ⏎ and then Esc to return to the DOS prompt.

Note: If non-rechargeable batteries are fitted, you must select **`disabled`**.

When you have finished, press ⏎ and then Esc to leave the HOT key.

If the HOT key does not work or the **`Power`** option is not displayed, the application may provide similar facilities. If you are not sure, refer to the application's user instructions, or ask your system provider.

If the HOT key shows that the batteries are chargeable, but they still will not recharge, they may need replacing. See section 8.2.2.4 for details.

You will find more details on the HOT key and charging configuration in section 11.5.

Note: Even if the main batteries are removed or completely discharged, the contents of the RAM and clock will still be preserved by another independent battery which is fitted internally. This should protect the contents of the memory for 2 to 3 days, but does not allow operation. If the **MP2500** may be without power for more than a few days, copy any files that you want to keep to disk.

8.2.2.3 Caring for rechargeable batteries

In normal use, the rechargeable battery stick will last 12 to 18 months before needing to be replaced, although its life is reduced by repeated or prolonged total discharge and by excessively high temperatures. During this period, the capacity should only decrease slightly. However, batteries may also exhibit a "memory effect" which reduces their capacity (temporarily) if they are repeatedly recharged when only partly discharged. This memory effect applies to NiCd batteries, but is less noticeable with NiMH batteries.

Therefore, to maintain battery capacity, follow these simple rules:

- NiCd batteries should not be recharged when they still have a significant charge remaining - they prefer full discharge cycles.
- NiMH batteries should be topped up with charge frequently - they prefer shallow discharge cycles.
- However, don't leave recharging until the batteries are completely exhausted.

- Don’t store the batteries (or **MP2500**) at high temperatures.

- New rechargeable batteries typically require 5 charge-discharge cycles to achieve their full rated capacity.

If battery capacity drops prematurely, it may be caused by the memory effect - this is particularly likely with NiCd batteries. Try putting the batteries through several full charge/discharge cycles, as follows (also see section 32.2.1.2):

- Run the **MP2500** until it displays battery low warnings and then charge it fully.

Repeat the discharge/recharge cycle two or three more times. If this does not restore the battery capacity, you should replace them as described in the next section. Note that cycling may also improve the performance of old batteries, but this is purely temporary, so the batteries should be replaced.

8.2.2.4 Replacing rechargeable batteries

With typical usage patterns, you will need to replace the rechargeable battery stick every 12 to 18 months, to maintain a reasonable capacity. To replace the battery stick, follow the instructions in section 8.2.3.2, then charge it fully as described in section 8.2.2.2.

Note: Several discharge/charge cycles may be required before rechargeable cells reach their peak capacity.

8.2.2.5 Rechargeable batteries: technical details

Readers requiring more details on **HUSKY** rechargeable batteries and their use in the **HUSKY** FS series hand-held computers should request Technical Note 530 from **HUSKY**. (See Appendix H.)

8.2.3 Using non-rechargeable batteries

THESE INSTRUCTIONS RELATE TO PERSONNEL SAFETY AS WELL AS RELIABLE OPERATION OF THE MP2500 AND AC ADAPTOR. IT IS IMPORTANT THAT THEY ARE READ AND UNDERSTOOD.

We recommend the use of Alkaline batteries, such as Panasonic or Duracell LR6 (MN1500) cells. You will need three AA-size batteries to operate the **MP2500**.

CAUTION: Do not mix batteries of different types, sizes, or states of charge. Do not fit Lithium batteries under any circumstances.

Alkaline batteries in **MP2500** are only suitable for light duty applications, and are not recommended for low-temperature use.

We do not recommend use of the cheaper Zinc-Carbon batteries for routine operation, as they may leak (damaging the **MP2500**), have shorter lives, and may cause technical problems. You may however use such batteries for short periods, in an emergency.

Alkaline cells should provide up to 10 hours of operation when running a typical application, and a shelf life of several months when installed in the **MP2500**. There is no need to remove them during shipment or storage, but remember that their charge will decrease with time.

Usable alkaline battery capacity is significantly reduced by operating at low temperatures or with additional loads.

8.2.3.1 When to change non-rechargeable batteries

Alkaline batteries **typically** provide approximately 10 hours' operation (depending on use), so if a unit is being used frequently, you might need to replace its batteries each day or two.

You should also change the batteries if:

- The following message is displayed every few seconds when you turn on:

  WARNING BATTERY LEVEL LOW

- A similar message is displayed by the application saying that power is low.

- The **MP2500** will not power up.

- You know that the batteries are nearly exhausted and will be relying on the batteries for an extended period.

To avoid problems, issue users with a spare set of batteries.

Note: If the main batteries are removed or completely discharged, the contents of the RAM and clock will still be preserved by another independent internal battery, for 2 to 3 days at 20°C (68°F). This battery does not allow operation. If the **MP2500** may be without power for more than a few days, copy any files that you want to keep to disk first, for added security.

8.2.3.2 How to change non-rechargeable batteries

CAUTION: Do not mix batteries. Replace all 3 at the same time, with batteries of the same type.

To change the batteries:

- Turn off.
- Use a COIN to unscrew the battery cap. (A screwdriver may damage the slot and the **MP2500** appearance).
- Remove the old batteries and dispose of them safely.
- Feed in the cells carefully, positive inwards. If you are fitting AA-size batteries, insert them in the battery packing tube (supplied with **MP2500** alkaline option at time of order only).
- Take the battery cap and, with finger pressure only, press it into the battery compartment and turn it clockwise.
- Only when the thread is started, use a coin to screw the cap tightly home.
- Turn on and you should be able to carry on from where you left off using the **MP2500**.

8.2.4 Using the AC adaptor

Note: The AC adaptor is intended for use only with **HUSKY** rechargeable batteries fitted to the **MP2500**. It is also safe to operate the **MP2500** direct from the AC adaptor without batteries.

8.2.4.1 If rechargeable batteries are fitted

To use the **MP2500** AC Adaptor with rechargeable batteries fitted:

1. Make sure that charging is enabled.

2. Switch off the **MP2500**. If alkaline batteries are fitted, remove them and fit the **HUSKY** NiCd or NiMH battery stick; see section 8.2.3.2.

3. Plug the AC adaptor into the **MP2500** 9 way D-type connector. Push the plug in until the outer sleeve is flush with the casing.

4. Plug the AC adaptor into an AC outlet and switch on the AC outlet.

5. You can now turn on and use the **MP2500** as normal, except that it will not power any peripherals.

Note: The AC Adaptor may not be able to simultaneously power the **MP2500** and high power peripherals or PC Cards. Ensure that these are powered off whilst charging the **MP2500** batteries. Otherwise, charge times may be extended, or the **MP2500** may switch off.

To disconnect the mains adaptor:

1. Turn the **MP2500** off.

2. Turn the AC outlet off and unplug the adaptor from the outlet.

3. Unplug the adaptor from the **MP2500**.

8.2.4.2 If alkaline batteries are fitted

CAUTION: **NEVER connect the AC adaptor if alkaline batteries are installed and charging is enabled. The MP2500 will attempt to charge the alkaline batteries, which will make them leak corrosive chemicals which are hazardous and will damage the MP2500.**

8.2.5 The power management system

This section provides background information on the **MP2500** power management system.

8.2.5.1 Data protection (RAM and Clock)

An internal rechargeable NiMH backup battery is fitted, which is trickle charged from the main power source (eg the main battery) and used to protect the contents of the RAM and clock if the main battery fails or is removed.

This backup battery is recharged from the main battery whenever the **MP2500** is switched on and running (except in power save mode). Depending on how much the **MP2500** is used, it may take a long time to charge a fully discharged backup battery - as long as 28 days or more.

If you need to charge the backup battery faster than this, connect the AC adaptor - the backup battery will be fully recharged within approximately 72 hours, e.g. 5 overnight charging sessions. However, the backup battery will be adequately charged for normal purposes after a single overnight charging session.

This backup battery should not need replacing, and is not user-accessible.

A **fully charged** backup battery will support the RAM contents for 12-18 hours at normal room temperatures.

The calendar clock (RTC) also has its own dedicated Lithium backup cell, which is non-rechargeable. Even if the main battery and backup battery are fully discharged, this Lithium backup cell will maintain the clock for up to 10 years.

8.2.5.2 Power monitoring

The **MP2500** monitors battery *voltage* and displays power warnings when this drops below a fixed threshold. Users cannot monitor power levels. The **MP2500** does not support fast charging. Once charging is detected by inserting the charger, a constant current appropriate for the battery type will flow for a maximum time of 8.5 hours (for a NiCd battery) or 12 hours (for a NiMH battery) after which the charge current will drop to a maintenance charge (NiCd) or zero (NiMH). This enables both NiCd and NiMH batteries to be left on charge safely for long periods.

For information on using the HOT key to set up the power options, see section 11.5.

8.2.5.3 Low Battery Warning

The **MP2500** is designed to provide adequate warning of impending battery failure and will protect user's data, even in the worst situations.

Warnings are given when the battery voltage is getting low. The low power warning message is displayed on the top line of the screen and looks like this:

```
WARNING BATTERY LEVEL LOW
```

The **MP2500** bleeps to draw attention to the warning, displays it for a few seconds, then restores the original display until the next warning. Warnings are displayed every 10 seconds.

Since it is usually essential that all data and programs are preserved, the user should save any files disk and switch off as soon as practical and either replace the batteries with a fresh set or, if rechargeable batteries are fitted, put them on charge.

If the user does not turn off, the warnings will be repeated every 10 seconds. After ten consecutive warnings, the **MP2500** will switch off automatically (unless overridden by your application).

When power is restored, program execution will continue from precisely where it was prior to the interruption.

If the user tries to use the **MP2500** without replacing or recharging the batteries or connecting an AC adaptor, another warning message will be displayed and it will immediately turn off again.

If the battery level falls so low as to endanger the RAM contents, the **MP2500** hardware will turn off to preserve the memory, without displaying a warning message.

Note that flat batteries can recover partially after being switched off, allowing operation for a short period. This is not good practice, particularly with rechargeable batteries, as these could become totally exhausted.

8.2.5.4 Idle Timeout

If the **MP2500** is left turned on and not used, to conserve power it will emit a warning bleep and switch off automatically if the keyboard is not touched for 5 minutes (this period may be changed by using the HOT key (see section 11.4.2) or by an application program: see Part 3). When the user turns on again, execution will continue normally.

8.2.5.5 Power Save

An automatic power conservation system is incorporated which monitors operation and removes power from circuits when they are not in use. The **MP2500** will enter power save mode automatically whenever it is waiting for keyboard input or serial input; this has no effect on operation other than prolonging battery life.

8.2.5.6 Controlling charging

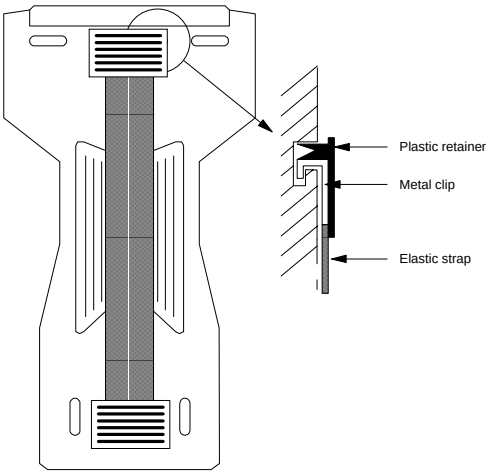
The **MP2500** can be used with Alkaline (non-rechargeable), NiMH or NiCd (rechargeable) batteries. NiMH and NiCd batteries can be charged by fitting the AC adaptor, but Alkalines must not. Attempting to charge Alkalines will cause them to leak corrosive chemicals, which are hazardous and will damage the **MP2500**.

Charging may be enabled or disabled by the user or by the application.

Refer to section 11.5 for information on using the HOT key to set up battery charging.

8.3 The handstrap

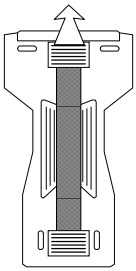
The **MP2500** is normally fitted with a hand strap, which fastens to the back of the unit.



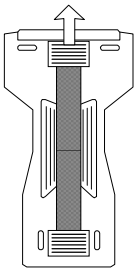
It is held in place by two metal hooks at each end of the strap, that fit into circular recesses at the back of the unit, and plastic retianers that also clip into the recesses. The tension in the elastic strap also helps hold the hooks in place.

To remove the hand strap:

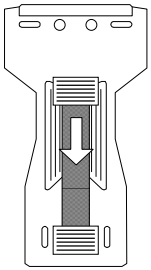
- Turn the **MP2500** over and grip the plastic retainer at one end. Pull it up to unclip the plastic clip from the recesses.



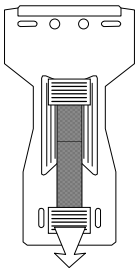
- Now, stretch the strap and the hooks should slide backwards so you can lift them out of the recesses.



- Release that end of the strap. Lift the retainer from the other end to unclip it and the hooks should slide from their recesses.



- You should now be able to remove the strap from the **MP2500**.



To fit a new hand strap, familiarise yourself with the main diagram above, then:

- Turn the **MP2500** over.
- Fit the hooks at one end of the strap into one set of recesses. Press the plastic retainer into the recesses.
- Grip the retainer at the other end of the strap and stretch the strap to reach the other set of recesses.
- Insert the hooks and let go. The strap should snap into place. Press the retainer into the recesses and the job is complete.
- Check that the hooks are properly seated (the retainers are flush with the **MP2500** case) and that the strap is firm.

8.4 The keyboard overlay

The **MP2500** is normally shipped with a self-adhesive keyboard overlay fitted, which may be customer-specified or one of the standard layouts. Overlays can be removed and replaced.

To remove an overlay:

- Insert a fingernail under one corner of the overlay and lift it gently away from the keyboard in that corner.

- Now peel the overlay off.

Note: To remove the overlay from the optional membrane keyboard, peel it back with a rolling action parallel to the keyboard. Take care not to damage the rubber membrane. Do NOT pull the overlay vertical to the rubber membrane.

To fit an overlay:

- Clean the keyboard area if necessary. Make sure that it is quite dry.

- Peel off the backing paper from the new overlay.

- Gently lower the overlay over the keys, making sure that the edges of the keys do not foul it, particularly when they are pressed. (The keys are hinged at the front.)

- When you are sure that the overlay is correctly positioned, press it firmly into place.

8.5 Storage

If storing the **MP2500**, observe the storage conditions described in Appendix B4.

During storage, all data and program files on the **MP2500** non-volatile CompactFlash disk are safe from loss and corruption, irrespective of the state of the main battery or backup battery.

For normal periods of storage, you can store the **MP2500** with batteries fitted; check these at regular intervals (typically once a month), for any signs of leakage. If the batteries are deteriorating, remove or replace them at once.

For extended storage, we recommend you remove the batteries.

8.6 Repairs and upgrades

If anything should go wrong with the **MP2500**, it is covered by a warranty. For the terms and details of this warranty, contact your supplier.

Repairs should only be performed by your Authorised Service Agent or **HUSKY**. In the first instance, contact your distributor.

You should also contact **HUSKY** or your local distributor if you want to extend the **MP2500** facilities by adding extra internal options.

9. Troubleshooting

The **MP2500** is designed, built, and tested for ruggedness, including robustness of program execution.

However, as with any complex system, things may go wrong, particularly while users are unfamiliar with its operation.

This chapter provides a simple introduction to diagnosing and solving problems which may arise in the field. Detailed information on problems which may arise while using the facilities described in this manual are provided in the chapters describing how to use them. For information on troubleshooting operation from MS-DOS, see the *MS-DOS Programmer's Manual*.

9.1 Common Problems

There are some specific situations that can cause the **MP2500** to execute an application incorrectly. The commonest causes are as follows.

9.1.1 Programming errors

Applications may include bugs that would crash any computer. Programmers are of course responsible for the logical correctness of their programs.

Applications may make invalid system calls, with unpredictable results. Programmers must remain within the programming guidelines included in this guide and the *MS-DOS Programmer's Manual* if they wish their programs to behave correctly.

9.1.2 Physical abuse

Excessive physical abuse may damage the unit. In most such instances, the physical cause will be obvious. Contact your supplier for repairs.

If the humidity indicator changes colour after an accident involving water or high humidity, the sealing is faulty and there could be water inside the unit. If you suspect that water has entered the interior, you MUST remove the batteries to minimise the risk of corrosion.

9.1.3 Operation outside specified temperature range

The **MP2500** is specified for operation in the range -30°C to +60°C (-22°F to +140°F). Operation at low temperatures restricts battery capacity and slows LCD screen response time.

9.1.4 Keyboard operation

The standard keyboard has individual moving keys. If the keys seem stiff, they may be fouling the keyboard overlay. This is particularly likely at the top edge of the keys. Try removing and refitting the overlay. If you cannot refit it, you need to fit a new overlay. If the overlay is not the problem, check to see if the keyboard area is contaminated. If it is, the unit should be returned for servicing, but you may be able to improve operation in the mean time as follows.

If the keyboard is contaminated with a dry powder or dust, you may be able to remove it by using a high pressure air-line.

If the keyboard is contaminated with a wet or sticky substance such as coffee or grease, clean it carefully as described in section 8.1.

The optional membrane keyboard is impervious to normal dust, moisture, and contamination. When dirty, it can be cleaned with a detergent solution. Do not use abrasive cleaners, or solvents.

9.1.5 Pressure differences

As the case is sealed, under certain circumstances (such as change of altitude) the interior of the **MP2500** may develop a substantial pressure difference compared with the environment. Loosen and then tighten the battery cap.

9.2 Diagnosing and Solving Problems

There are two main classes of problem that you might have.

The first class consists of problems which the **MP2500** reports to you, by displaying an error message, a short description of the problem. For example, **`Insufficient disk space`** means that there is not enough space on the disk for an operation.

This class of problems should be quite easy to handle. The error messages produced by MS-DOS are described most MS-DOS user guides. The error messages produced by the special **MP2500** utilities are described in the chapters about those utilities. The error messages from third party applications will of course not be included in this guide - see the application's own guides for details.

The second class of problems are those that are not accompanied by an error message. You realise that there's a problem because the **MP2500** doesn't do what the user wants, or does something that the user doesn't want.

Always check that the user has followed the instructions for their application first, to make sure that the error is not theirs.

Problems of this type which may arise with a standard system include:

Symptom	**Cause - remedy**
Won't power up	AC adaptor disconnected or faulty and no internal batteries or batteries discharged. - Recharge or replace as described in section 8.2, then try again. If this does not work, either the batteries or the AC adaptor have failed; contact your local representative.
Screen blank or all dark	The LCD contrast is incorrectly set - particularly likely at temperature extremes. - Hold down ⇧ and press ↑ or ↓ until the LCD Screen contents become visible.

Symptom	Cause - remedy
Battery life is shorter than expected	This is normally caused by the application preventing the **MP2500** from entering Power Save mode. In our experience, this can be overcome - contact the **HUSKY** Support Department or your system supplier for assistance. See also Appendix G4.
Powers up in an application	This will happen if an application was running when the **MP2500** was turned off. - If you want to use an MS-DOS command or a different application, leave the application as described in its user instructions. This will take you to MS-DOS command mode and preserve all your application's files.
Don't know how to leave application	- If the user instructions don't tell you how to leave the application, ask your system provider. - If this does not help, press Ctrl+🐾+Esc or Ctrl+C which should take you to MS-DOS command mode. OR reboot by pressing Ctrl+Alt+Del. (If the program starts automatically on a reboot, press left ⇧+F1 or Ctrl+🐾+Esc or Ctrl+C during the reboot to prevent this.) - If neither method works, see 'Can't leave application', below. CAUTION: Either method will corrupt any files that the application is writing to at the time, so use them only as a last resort.

Symptom	Cause - remedy
Program runs when you power up	The program has been installed to run automatically, typically by including a command in the file C:\AUTOEXEC.BAT. - If you want to use a different program, leave it as described above, or press left ⇧+F1 or Ctrl+🐾+Esc or Ctrl+C during the reboot to prevent this. - To stop the program running automatically, delete the appropriate command from the C:\AUTOEXEC.BAT file, or ask your technical support team to do this for you.
Won't power down	The current application is in 'continuous power' mode, probably because it is performing an operation which should not be interrupted, such as transmitting a file via the serial port. A message should be displayed to this effect. - Wait until the operation has finished and you should be able to power down normally. - If you cannot wait, or believe that something has gone wrong, leave the application as described above, and you should be able to power down normally. - To power down without leaving the application, remove and refit the battery cap (and disconnect the charger if connected). The application will continue normally when you turn on again.
Beeps when you press a key	You have pressed an invalid key. A utility is waiting for you to make a selection by pressing one of a particular group of keys. - Press one of the keys indicated on the screen.

Symptom	Cause - remedy
Keyboard behaves strangely	A previous application has redefined the keyboard, so that keys have different effects to normal. - If you are in an application, leave it first (see above), then reboot by pressing Ctrl+Alt+Del See also: *Keyboard modes*, section 7.4.3, and *International keyboards*, section 5.4.5.
Can't leave application Or Locks up Or Behaves strangely	Program crash or hardware failure. - Reboot by pressing Ctrl+Alt+Del OR if this won't work, remove and refit the battery cap (and disconnect the charger, if connected), then turn on again. If normal operation resumes, carry out the checks described in the next section. - Finally, if you have been supplied with instructions for the EMERGENCY HARDWARE RESET (on subsequent pages), try that. If you cannot restore normal operation, contact your technical support team or system provider.
The Real Time Clock (RTC) gains over the DOS clock	An application is not allowing the **MP2500** to enter Power Save mode. (The BIOS synchronises the two clocks each time the **MP2500** wakes up out of Power Save mode.)

Report any persistent problems to your system provider.

Pressing Ctrl+C or Ctrl+Fn+Esc will often abort an application, while Ctrl+Alt+Del will normally reboot, but either or both may be disabled by an application.

Pressing ⏻ will usually turn off but this may be disabled by an application.

Removing and refitting the battery cap will always turn off the unit, but when you turn on again, the **MP2500** will usually power up in the application that was running when you turned off.

Under normal circumstances the **MP2500** should be very reliable, but if you use it for software development, a user program may crash and 'lock up' the machine. If this happens, try the following emergency breakout procedures. If these do not help, contact your local distributor or **HUSKY**.

Emergency breakout

Use this facility to break out of any application. You may wish to restrict access to the information on this page.

Note: The following description is for the standard English keyboard layout shown at the start of Chapter 1. If you are using a different keyboard, press the keys in the corresponding positions; their legends may differ.

If you cannot break out of a program for some reason, the following should always work unless there is a serious hardware malfunction:

1. Turn the **MP2500** off (e.g. remove and replace the battery cap).

2. Hold down the X and P keys.

3. Press ⓘ briefly and release X and P.

4. The **MP2500** should exit any program and reboot (unless there is a hardware malfunction). You may however require several attempts, as timing is critical.

Emergency hardware reset

Use this facility to reset a machine on which emergency breakout fails.

1. While holding down both ⇧ keys, press ⓘ. Hold down all three keys for at least 5 seconds, then release them all.

2. The machine should exit any program and reboot. If it does not, there is a hardware malfunction: contact your system supplier for repairs.

Note: You should now carry out the checks described in the next section, to make sure that the **MP2500** will now operate correctly

9.3 Checks

If an application has crashed, it may have corrupted other parts of the system. You (or your technical support team) should select MS-DOS command mode and carry out the following simple checks, to make sure that future operation is not compromised.

9.3.1 Communications

The communications configuration may be affected by a crash, and will be indicated when you attempt to use or configure communications using the UTIL application.

Use the UTIL application to check and, if necessary, correct the configuration.

9.3.2 Real Time Clock (RTC)

The RTC may be corrupted, as shown by an incorrect or impossible time or date.

Use the UTIL application to check and, if necessary, correct the time and date.

9.3.3 Files

An application may corrupt any disk files that it was writing to when it crashed or was reset or rebooted. Files are not affected by turning on and off.

If any of these events occur, check what files are written to by the application and, if you have access to recent copies (backups), delete the current versions and use the backups.

If you do not have recent copies, run the application but check the state of the files carefully.

(An application running on a conventional desktop computer may also corrupt any disk files that it was writing to when it crashed or was reset or rebooted. A desktop computer is actually more likely to corrupt files, because a power failure part way through a write will normally corrupt the file too.)

If the boot drive (normally drive C) is badly corrupted, the unit will not boot. You may need to reformat it, re-install the operating system, or select another boot option. For details of all these procedures, see Chapter 10, *The Utilities*.

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10. The Utilities

This chapter describes the main **MP2500**-specific configuration utilities:

- **UTIL** is a general-purpose utility that provides access to a number of functions unique to the **MP2500**. Section 10.1 summarises how to use these functions, for ease of reference. They have also been described in context elsewhere.

- The **BOOT OPTION** menu provides configuration of booting and internal drives. See section 0 for details.

- **ORACLE** is a utility that is run on a PC to allow the **MP2500** to use its A drive. See section 10.3 for details.

This chapter also includes:

- A detailed description of formatting the CompactFlash drive: see section 10.4.

- A brief description of Microsoft's INTERLINK utility, which can be used to access a PC's drives and printers from the **MP2500**: see section 10.5.

10.1 The UTIL utility

The functions provided by UTIL are not intended for everyday use. Indeed, you may never need to use them. For more detailed information on how and why you should use them, see:

Function	**Chapter**
Set time/date	Correcting the time (eg when crossing time zones): Chapter 5.
	If the clock gets corrupted: Chapter 9.
Format diskette	To produce an emergency boot diskette: Chapter 10.1.4.
Communications	Setting up communications ports: Chapter 13.

Function	Chapter
ports	
Non-volatile configuration	Setting up: Chapter 10.1.5.

10.1.1 Using UTIL

You can use UTIL in two different ways. The usual way is as a menu-driven utility:

1. Select MS-DOS command mode
2. Type: **C:\UTIL** ⏎
3. This displays the main UTIL menu, like this:

4. The keys that you can use are displayed at the base of the screen. For example, to select an option, move the highlight to it by using ← or → then press ⏎.
5. To return to MS-DOS command mode, press Esc.

The other way to use UTIL is as a command line utility:

1. Select MS-DOS command mode
2. Type: **C:\UTIL** followed by the switches for the commands to perform.
3. When you press ⏎, UTIL performs the specified commands and then returns to MS-DOS command mode.

For details of the command line commands, see section 10.1.7, *Command line switches*.

10.1.2 Set time

Use this option to set the system time. Note that the same facility is provided by the MS-DOS TIME command.

The screen will look like this:

Move the highlight to the time field that you want to change, by using the ← or → key, then adjust the value by using the ↑ or ↓ key. Press ↵ to accept the new time and return to the main UTIL menu, or press Esc to cancel the changes.

10.1.3 Set date

Use this option to set the system date. Note that the same facility is provided by the MS-DOS DATE command.

The screen will look like this:

Move the highlight to the date field that you want to change, by using the ← or → key, then adjust the value by using the ↑ or ↓ key. Press ↵ to accept the new date and return to the main UTIL menu, or press Esc to cancel the changes.

Note that the **MP2500** adjusts the month length for leap years, but does not adjust for local changes such as Summer/Winter (Daylight Saving) time changes.

10.1.4 Format diskette

Use this option to format diskettes for use with the **MP2500**. As the **MP2500** diskette format is entirely standard, you only really need to use this option to create a bootable **MP2500** diskette i.e. a diskette with the special **MP2500** IO.SYS file on it. You can then use it to boot a unit that won't boot from its internal drive (e.g. if the boot tracks get deleted or corrupted). (You can also use the **HUSKY** Utilities Diskette to recover from such situations, as described in chapter 10.3.1.)

Note: Do not use a PC generated boot disk, as this will not contain the special MP2500 files.

To format an **MP2500** bootable diskette:

1. Connect the unit's serial port to a serial port on a PC, using a standard "crossed" (null modem) cable.

2. Run the **ORACLE** utility on the PC to make it share its A drive. (See section 10.3 for details). Set the Baud rate to 19,200 Baud by using the **/19200** switch.

3. Insert the diskette to format in the PC's A drive.

4. Run UTIL and select the **`Format diskette`** option and this screen will be displayed:

5. Use ↑ or ↓ to set the **`Density`** to **`1.44Mb`**.

6. Use ← or → to select the **`Drive`** option, then use ↑ or ↓ to set it to **`A:`** or **`B:`**.

7. Use ← or → to select the **`Write system files`** option, then use ↑ or ↓ to set it to **`Yes`**.

8. Press ↵ to continue and you'll see a screen like this:

9. Press any key other than Esc to begin formatting. Press Esc twice to abort.

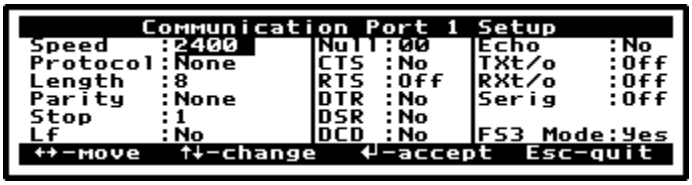
10.1.5 Communication Port Setup

The **MP2500** serial communications port (Port 1) is permanently assigned as COM2. Use these options to select and configure **HUSKY mode** communications for COM2, or to restore **IBM mode** communications.

Note that **HUSKY mode** communications is referred to as **"FS3 mode"** on the set up screen (because this function is common between the **HUSKY MP2500** and **FS3**), and has the following advantages:

- Support for protocols (XON/XOFF and any optional protocols installed), providing more secure data transfer
- Configurable handshaking, to suit a wide variety of devices and connection methods
- Faster data transfer (up to 115,200 Baud) for efficient communications
- Data buffering for reliable fast transfer
- Compatibility with other **HUSKY** handheld computers (such as the **HUSKY FS3**)

This screen will look like this:



Note that the single **MP2500** communication port is **COM2** only, but is always referred to as Port 1 on the **MP2500**.

This shows the current configuration of the selected port, and allows you to alter it by using the cursor keys.

To restore IBM communications, simply set **FS3 Mode** to **No** and press ⏎.

To select **HUSKY** (**FS3 mode**) communications, simply set **FS3 Mode** to **Yes**, set the other parameters as required, and then press ⏎.

To cancel any changes you have made, press Esc.

You will normally simply select a configuration to suit the device that is connected to the port. For more details of the significance of the various options, see Chapter 13.

The configurations that you select will normally remain in force until you use this option again. However, IBM-style communications will be resumed if you use an application or command (such as **MODE COM1**) which re-initialises communications; to re-select **HUSKY** (**FS3 mode**) communications, simply select this option again.

Standard (MS-DOS) applications which control the port hardware directly (such as certain communications packages) will also ignore the configuration set using this option.

10.1.6 Non-volatile configuration

Use this option to change key aspects of the unit's configuration.

The screen will look like this:

Move the highlight to the field that you want to change, by using the ← or → key, then adjust the value by using the ↑ or ↓ key. Press ↵ to accept the changes and return to the main UTIL menu, or press Esc to cancel the changes.

To disable the Welcome screen (so the unit boots direct to DOS), set **`Welcome screen`** to **`Not display`**. (The default is **`Display`**.)

If the backlight option is fitted: to make the backlight turn back on when the user presses any key after it times out, set **`EL resume mode`** to **`Yes`**. (The default is **`No`** - the backlight does not turn on again automatically after it times out.) **`No`** is is recommended as it helps maximise battery life.

The charging current can be increased to take account of the higher capacities of NiMH batteries, compared to NiCd, to ensure that an overnight charge rate is still achieved. Set **`Charging type`** to **`NiCad`** or **`NiMH`** as appropriate. The default is **`NiCad`**.

If you make any changes in this menu, the unit will reboot when you exit this screen, to bring the changes into effect.

Note: You can also perform non-volatile configuration by using command line switches. For details, see section 10.1.7, *Command line switches*.

10.1.7 Command line switches

The UTIL command line switches are as follows:

`/a`*switch*	Ignored.
`/b`*switch*	Enables COM2 if *switch*=1, disables it if *switch*=0.
`/e`*switch*	Selects the new backlight mode if *switch*=1, selects the old backlight mode if *switch*=0.
`/f`*switch*	Enables powersave STOP mode if *switch*=1, disables it if *switch*=0.
`/i`*switch*	Ignored.

/l	Displays the non-volatile settings on the screen and the unit's serial number.
/m*switch*	Ignored.
/o*oemid*	Sets the unit oem string to *oemid*.
/p*switch*	Ignored.
/s*serialnumber*	Sets the unit serial number to *serialnumber*.
/w*switch*	Enables the welcome screen if *switch*=1, disables it if *switch*=0.
/x*password*	Supplies the password required for the **/s**, **/o**, and **/p** commands.

Note: Certain switches are accepted for compatibility with the **HUSKY FS3** but are otherwise ignored on the **MP2500**.

The switches may be used in any order and in any combination, except that the serial number and oem string commands require the password switch too. You must leave a space between each one and the next.

Caution: The unit will immediately reboot after using any of these switches.

10.2 The BOOT OPTION menu

You can use the Boot Option menu to choose which drive to boot from, and to change the drive order if two internal drives are fitted (the standard CompactFlash drive and an optional ATA PC Card).

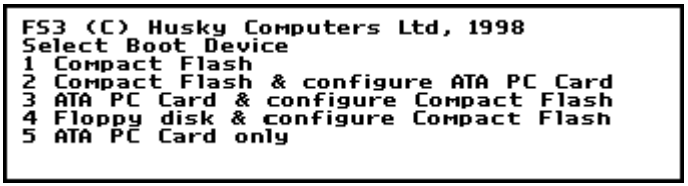
To use the Boot Option menu:

1. Reset the unit by holding down ⇧ + ⇧ + ⓘ .

2. If the Welcome screen is displayed, press ↵ to acknowledge it.

3. **Immediately** press **Alt** **+** **F1**. The normal boot process will terminate and a flashing cursor will be displayed at the left-hand side of the screen, below the **HUSKY** copyright message. (If not, repeat steps 1-3.) Type the

boot option menu password **YKSUH** ("HUSKY", backwards), which will not be displayed. This will display the boot menu:


FS3 (C) Husky Computers Ltd, 1998
Select Boot Device
1 Compact Flash
2 Compact Flash & configure ATA PC Card
3 ATA PC Card & configure Compact Flash
4 Floppy disk & configure Compact Flash
5 ATA PC Card only

4. Select the boot option you want by pressing the appropriate number key:

- Select **1** to set the CompactFlash device as drive C and boot from it.

- Select **4** to set the CompactFlash device as drive C, but boot from drive A. (When you select this option, another menu will be displayed, as described below in section 10.2.1.)

  Note: The standard **MP2500** does not provide support for ATA PC Cards, so boot device options 2, 3 and 5 are not valid. If you select one of these options by mistake, the boot process will not complete and the unit will "hang". Repeat the above procedure from step 1 and select a valid boot option device.

5. Press ⏎ and the unit will boot from the selected drive, which must contain the **MP2500** operating system. If you chose option 4 to boot from a diskette, you must set up the drive as described below.

Note: Whilst the unit is booting, there will be a noticeable delay and the display may go dark.

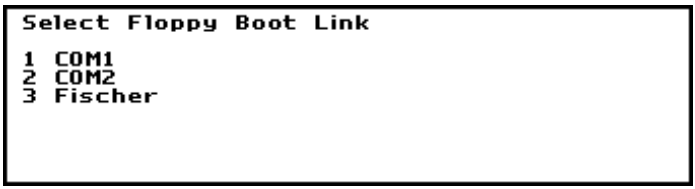
10.2.1 Booting from a diskette

If an **MP2500** will not boot from its internal drive, you can boot it from a suitable diskette, as follows.

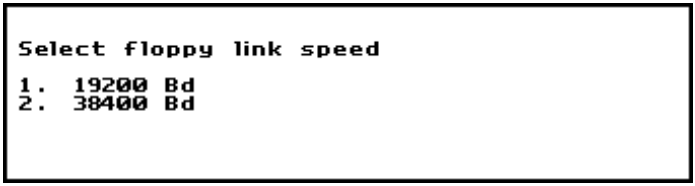
To boot from a diskette:

1. Connect the unit's serial port to a serial port on a PC, using a standard "crossed" (null modem) cable.

2. Insert the **HUSKY Utilities Diskette** (HUD) in the PC's A drive, or a bootable diskette produced by using the **MP2500** UTIL utility's **`Format diskette`** option (see section 10.1.4, *Format diskette*).
3. On the PC, select the A drive, type **`ORACLE/19200`** and press **Enter**. (This makes the PC share its A drive via the cable.)
4. On the unit, display the Boot Menu and select option 4 to boot from a diskette, as described in section 0.
5. When you press ⏎ in the Boot Menu, this will prompt you for the port to use to connect to the PC:



6. Select option 2 to connect to the PC, then press ⏎.
7. The following screen prompts will be displayed:



8. Select the **19200** speed option, then press ⏎. The unit will boot from the diskette in the PC's drive.

Once the unit has finished booting, you can use the PC's A drive just as if it were attached directly to the unit. This provides a quick and easy way to copy files to or from the unit, or to produce more bootable diskettes. (To gain access to **all** the PC's drives and its printers, see section 10.4, The INTERLINK utility.)

Remember to return the unit to booting from the appropriate internal drive before issuing it - see section 0 for details.

Note: If you want to format the internal drive, see 10.4, *Formatting a CompactFlash drive*.

10.3 The ORACLE utility

The **ORACLE** utility is run on a PC, to allow an **MP2500** to access its A drive via a serial cable:

Type **`ORACLE /19200`** or **`ORACLE /19200/COM1:`** on the PC to connect via the PC's COM1 port.

Type **`ORACLE /19200/COM2:`** on the PC to connect via the PC's COM2 port.

The above commands connect at 19,200 Baud, the highest speed supported by the **MP2500**.

ORACLE's main purpose is to allow you to boot **MP2500** from a diskette, when it will not boot from its own drives - see section 0,

The BOOT OPTION menu for details. This menu allows you to specify which port on the **MP2500** connects to the PC, but a standard **MP2500** unit can only use COM2.

ORACLE can also be used to access the PC's A drive without using the Boot Option menu as follows, but the INTERLINK utility is much more versatile and recommended for this type of work. See section 10.5, *The INTERLINK utility* for details.

To access the A drive via **ORACLE**:

1. Connect the **MP2500** unit to one of the PC's serial ports via a crossed (null modem) cable.

2. If you've connected to the PC via its COM1 port, type **`ORACLE /19200`** and press **Enter** on the PC; if you've connected via its COM2 port, type **`ORACLE /19200 /COM2:`** and press **Enter**.

3. You can now access the PC's A drive as drive B.

10.4 Formatting a CompactFlash drive

Caution: Formatting a drive removes all files from it, including user and operating system files. Only format a drive if you no longer want the files on it, or if the disk is corrupt so you can't use it. If there are important user files on the drive (e.g. customer orders), try to copy them to another drive first, or print them off so you have some record.

If the CompactFlash drive becomes corrupted or the operating system has been deleted from it, to restore the unit to normal working order you will need to use the **HUSKY MP2500 Utility Disk** (**HUD**), as follows.

To format the CompactFlash drive as a bootable drive:

1. Connect the **MP2500** unit's serial port to a serial port on a PC, using a standard "crossed" (null modem) cable.

2. Insert the HUD in the PC's A drive and boot the PC from this diskette. (This loads the **MP2500** version of IO.SYS into the PC's memory, so that when you transfer the operating system to the **MP2500**, the correct version will be transferred.)

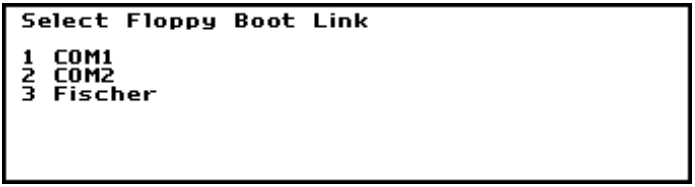
3. On the PC, select the A drive, type **`ORACLE /19200`** or **`ORACLE /19200/COM2:`** as appropriate and press **Enter**, to make the PC share its A drive via the specified port.

4. Reset the **MP2500** by holding down ⇧ + ⇧ + ⓘ. If the Welcome screen is displayed, press ↵ to acknowledge it.

5. **Immediately** press Alt + F1. Now type **YKSUH** (the boot menu password) and press ↵. This will display the boot menu:

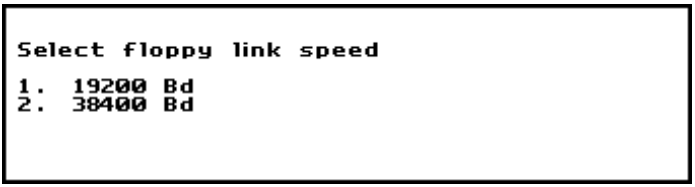
```
FS3 (C) Husky Computers Ltd, 1998
Select Boot Device
1 Compact Flash
2 Compact Flash & configure ATA PC Card
3 ATA PC Card & configure Compact Flash
4 Floppy disk & configure Compact Flash
5 ATA PC Card only
```

6. Select option 4, **Floppy disk & configure Compact Flash** and press ↵ - this will prompt you for the port being used to connect the diskette drive:



7. Select option 2 to connect to the PC, then press ↵.

8. The following screen prompts will be displayed:



9. Select the speed option, then press ↵. The unit will boot from the diskette in the PC's drive.

10. On the unit, type **B:FDISK** ↵ and use options 1 and 2 to create a DOS partition and set the active partition to C. Exit FDISK and the unit will reboot (from the HUD in the PC's diskette drive).

11. On the unit, type **B:FORMAT C: /S** ↵ to format drive C and copy the operating system files to it.

12. On the unit, type **B:IMAGE** ↵ to run the IMAGE.BAT file, to copy the default files to the drive C.

13. Reset the unit by holding down ⇧ + ⇧ + ⓘ. (If the Welcome screen is displayed, press ↵ to acknowledge it.) **Immediately** press Alt + F1. Now type **YKSUH** ↵ to display the boot menu again.

14. Select option 1 to make the CompactFlash the boot device, and press ↵ - the unit should now boot as normal.

15. Now, install any other files that are required on this unit and it's ready for use again.

To re-install the operating system and keep all the files already on the CompactFlash drive, don't format it, use the **SYS** command. First, carry out steps 1-9 as described above, then:

10. On the unit, type **`B:SYS C:`** ↵ to copy the operating system files to drive C.

11. Reset the unit by holding down ⇧ + ⇧ + ⓘ. (If the Welcome screen is displayed, press ↵ to acknowledge it.) **Immediately** press Alt + F1. Now type the **YKSUH** password and press ↵ to display the boot menu again.

12. Select option 1 to make the CompactFlash the boot device, and press ↵ - the unit should now boot as normal.

10.5 The INTERLINK utility

You can easily link to a PC to use any of its disk drives or printers by running Microsoft's **INTERLINK** utility, which is part of MSDOS 6.x, as follows:

Note: For full details of the INTERLINK utility, see your DOS Guides. This section only provides a brief summary of the process.

1. Connect the unit's serial port to a serial port on a PC, using a standard "crossed" (null modem) cable.

2. On the desktop PC, run the INTERLINK server: type **`INTERSVR.EXE`** and press **Enter**.

3. On the **MP2500** unit, install the INTERLINK driver by adding this line to the CONFIG.SYS file:

```
DEVICE=C:\DOS\INTERLNK.EXE
```

4. Reboot the **MP2500** unit, which will display a list of new drive letters and printer port names that now provide access to resources on the server PC, like this:

```
Microsoft Interlnk version 1.xx

   Port=COM1
   Drive letters redirected: 3 (D: through F:)
   Printer ports redirected: 2 (LPT2: through LPT3:)

   This Computer    Other Computer
     (Client)         (Server)
   ------------     -------------
        D:    equals     A:
        E:    equals     C:
        F:    equals     D:
        G:    equals     D:
        LPT2: equals     LPT1:
        LPT3: equals     LPT1:
```

5 Take a note of the drive letter to use for each drive on the PC, and the device name to use of each of its printer ports. For example, if you want to copy a file from drive A on the PC, you'll need to use the drive letter D on the **MP2500** unit.

6 Once you've finished using the link, terminate it (eg press **Alt+F4** on the PC), disconnect the cable, and remove the INTERLNK.EXE line from the **MP2500** unit's CONFIG.SYS file. Reboot the **MP2500** to remove the server program from memory, too.

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11. The HOT Key

This chapter summarises the facilities provided by the **MP2500** HOT key, which you can use to check or change certain key aspects of the **MP2500** set-up. Particular uses are described in more detail as appropriate elsewhere in this manual.

Note: To use the HOT key, you need the PAW function of the 🐾 key. The 🐾 key has two modes, providing either the PAW function or the BACKLIGHT (☼) function. If you press this key and it operates the (optional) backlight, toggle it back to PAW by holding down both ⇧ keys and pressing the key immediately above ↵ (⊙ in the standard English layout). (See section 7.4.3, *Keyboard modes* for more on keyboard functions.)

11.1 Introduction

To use the HOT key, press 🐾H. You do not have to be at the DOS prompt to use the HOT key. For example, you can use it while in the middle of an application, without interfering with its operation in any way.

The HOT key displays a screen like this:

This screen displays summary status information about the **MP2500** and provides you with facilities to adjust the screen, keyboard and (optionally) power settings.

The bottom line of the screen shows which keys to use. For example, to access the keyboard facilities, move the highlight to the **`Keyboard`** option by using the ← or → keys, then press ↵ to select it.

To return to the normal screen display, press Esc or press 🐾H again.

11.2 Status information

The status information is as follows:

- The time and date.
- The state of the Caps Lock and Num Lock keys.
- The battery charging support status (Disabled or Enabled). For details, see section 8.2.2.

11.3 Screen option

The **Screen** option displays the following:

Move the highlight to the options you want to change by using the ← or → keys, then adjust the displayed value by pressing the ↑ or ↓ keys. When you have finished, press ↵ to accept the changes or Esc to cancel them.

11.3.1 Text font

The **MP2500** can display text on the LCD in different sizes, e.g. 16x16, 16x12, 8x12, 11x8, 8x8, 8x6 and 6x4 (all sizes in pixels). The smaller characters allow you to display more text at a time, but you will probably find the larger characters easier to read.

You can adjust the text size at any time without 'confusing' your application.

If changing the text size has no apparent effect, your application is using the display in graphics mode, which does not support this feature.

11.3.2 Inverse video

If you are using an application which displays text using a variety of text colours or other attributes (such as high intensity), you may be able to improve the display by telling the **MP2500** to use 'inverse video' for these unsupported attributes. Either ask your technical support team which setting to use, or experiment until you achieve the best result.

11.3.3 Split screen

If an application maintains a status, message, or menu line separate from the main work area on the screen, you can tell the **MP2500** to display it permanently on the LCD by using the split screen facility. This splits the CGA and LCD into two parts (windows), displaying information from the top CGA window in the top LCD window, and the bottom CGA window in the bottom LCD window.

To do this, set **`Split Screen`** to **`Yes`**, then set **`Physical Row`** to the line (1..10) where you want to split the LCD and **`Logical Row`** to the line (1..25) where you want to split the CGA.

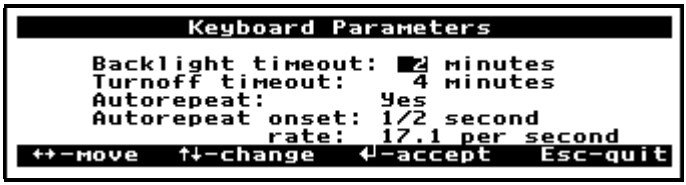
You can also control scrolling for each window by changing the values displayed against **`Top`** and **`Bottom`**. If you set this to **`Yes`**, the LCD window will scroll to show anything you type while the cursor is in that part of the CGA. If you set this to **`No`**, the LCD window will not scroll automatically, although you can scroll both windows by using the 'viewing keys' (see section 7.3.3).

11.3.4 Cursor synchronisation

This option allows you to decide whether the LCD should scroll automatically to keep the cursor visible, or only when you operate the 'viewing keys' (see section 7.3.3). Leave this set to **`Yes`** unless you encounter problems with an application.

11.4 Keyboard option

The **Keyboard** option displays the following:



Move the highlight to the options you want to change by using the ← or → keys, then adjust the displayed value by pressing the ↑ or ↓ keys. When you have finished, press ↵ to accept the changes or Esc to cancel them.

11.4.1 Backlight timeout

This value controls how long the optional backlight will stay turned on, if a user does not press any keys. You can set it to between 1 and 5 minutes, or disable it entirely. The default is 2 minutes.

To improve battery life, leave this feature enabled and set the timeout to the lowest value acceptable to the user (such as 1 or 2 seconds).

If the backlight is turned off by a timeout, it turns on again as soon as the user presses a key. This timeout is mainly provided to help save battery power when a user forgets to turn the backlight off. (To improve battery life still further, you can configure the backlight not to resume automatically - see section 10.1.5.)

11.4.2 Turnoff timeout

This value controls how long the **MP2500** will stay turned on, if a user does not press any keys and communications is not active. You can set it to between 2 and 60 minutes, or disable it entirely. The default is 5 minutes.

This timeout is mainly provided to help save battery power when a user forgets to turn off! Remember that a user can normally turn on again and continue exactly where they left off.

To improve battery life, set the timeout to the lowest value acceptable to the user.

11.4.3 Autorepeat

The onset value is the delay before a key will start to autorepeat if left pressed. The rate is the number of depressions per second which will be 'typed' by autorepeat. You can set the onset to 1/4, 1/2, 3/4 or 1 second. You can set the rate to between 2 and 30 characters per second. The default delay is 0.5 seconds and the default repeat rate is 17.1 characters per second.

11.5 Power option

This option allows you to switch the charging option on or off. The option can be disabled by the application. Selecting this option displays the following:

To change the charging mode, use ↑ or ↓ to select **Enabled** or **Disabled** and press ↵.

11.5.1 Battery Charging Support: Disabled

Use this setting to disable charging. You must select this setting if alkaline batteries are fitted, so as to prevent charging.

11.5.2 Battery Charging Support: Enabled

Use this setting to enable charging when rechargeable batteries are fitted.

11.5.3 Charging type

MP2500 supports two different rechargeable battery types, selected by using UTIL - see section 10.1.6 (Non-volatile configuration). Set the charging type to **`NiCad`** or **`NiMH`** as appropriate if you intend using rechargeable batteries.

11.5.4 Charging termination

For a fully discharged battery, the **MP2500** requires up to 8.5 hours to charge a NiCd battery and 12 hours to charge a NiMH battery, After charging for 8.5 hours (NiCd) or 12 hours (NiMH), the message **`Charging Complete`** will be displayed. After a further period of 1.5 to 2 hours the charging current will automatically reduce to a small maintenance charge (NiCd battery) or zero charge current (NiMH battery). This mechanism means that you can safely leave the unit to charge unattended. Charging is also automatically disabled if the ambient temperature rises above 40°C (104°F) or falls below 0°C (32°F) (nominal).

12. The Editor

This chapter describes ED, the **MP2500** text editor which is resident on your **MP2500**.

Note: To use many editor facilities, you need access to the Ctrl key. This key is available in the developer (default) keyboard mode, but not the user keyboard mode. To toggle keyboard modes, hold down both ⇧ keys and press the key immediately above ↵ (⊙ in the standard English layout).

12.1 Introduction

ED is quick and easy to use, providing a wide range of screen-editing functions. You can use ED to write, alter or examine standard ASCII text files, such as CONFIG.SYS and batch files, and GWBASIC programs that have been saved in ASCII form (i.e. by using the command **SAVE "name", A**).

12.2 Selecting ED

To use the editor, select MS-DOS command mode and type:

ED [*filename*] [*options*] ↵

Where ***filename*** is the name of the file to edit or create (see section 12.3) and ***options*** can be used to change behaviour of the editor (see section 12.4). For example:

ED C:\DATA\MYFILE.TXT /KEY /60 ↵

12.3 File handling

If you specify a filename in the ED command, and the file exists already, it will be loaded into memory for you to edit. If the filename includes a DOS drive or pathname, this drive or directory will also be used as the default drive and directory for all file operations within ED.

If you do not specify a drive or pathname, the current drive and directory are assumed. If you omit the extension, TXT will be assumed. If you do not specify a filename, ED will assume the filename **NONAME.TXT**.

ED uses the free DOS memory for the file you are editing, so this dictates the maximum size file you can edit. If a file is too large to edit, the following message will be displayed:

```
Disk read incomplete- file too big
```

and you will only be able to edit the first part of the file. If you want to do this, make sure that you save it with a different name, or you will lose the remainder of the file.

If your edits increase the size of the file to the limit of available memory, you will see the message:

```
Short of memory- save file NOW!
```

If you want to continue editing the file, either split it in two (by using the BLOCK WRITE command), or delete some text before carrying on.

Editing takes place in memory, so it has no effect on the disk file until you use the SAVE command. You can save the file with the same name, or use a different name, drive or path.

12.4 ED options

You can alter various aspects of ED's behaviour by including options in the ED command. These are as follows:

Option	Description
/IGNORE	When searching for text, ED will normally not match capital and small letters. Use this option to ignore case during searches, so that, for example, searching for **the** will match **the**, **The**, **THE**, etc.
/LF	ED normally stores the ↵ key as CR-LF character pair (ASCII 0DH, 0AH). Use this option to store it as a CR character (ASCII 0DH).

Option	Description
/WRAP	Lines which are longer than the LCD will normally extend to the right of it, so you must use the cursor keys to view the line ends. Use this option to turn wrapping on, so that text will be formatted to fit in the LCD window.
/TAB	TABs are normally stored in the file as a number of spaces. Use this option to store them as TAB characters (ASCII 09H).
/60	ED normally uses the 8x6 font, displaying 8 lines of 40 characters on the LCD screen. Use this option to select the smaller 6x4 font, to display 10 lines of 60 characters.
/KEY	ED normally uses the current keyboard mode. Use this option to force the default keyboard.
/BROWSE	ED normally allows editing. Use this option to select browse mode, which prevents editing.

To select an option, include it in the ED command after the filename, separated by a / character. You can type options as capitals or small letters, abbreviate them by supplying just the first one or two characters, and can use them in any combination or order, as long as they are separated by / characters.

For example, to select a 60-character screen, force the default keyboard and disable wrapping, type:

ED *filename* /60/KEY/WRAP

or even:

ED *filename* /6/K/W

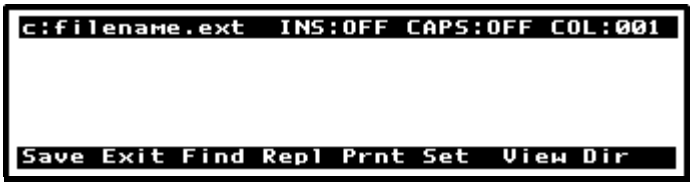
You can also select some of these options from within ED by using the SET command (see later).

You can also change the line wrap, font, line delimiter and case ignore settings by using the SET command (see later), once ED has loaded.

12.5 Editing screen

The normal mode for the LCD displays 8 lines of 40 characters, but the 60 option displays 10 lines of 60 characters.

On entry to ED (in the normal 40-character mode), if the specified file does not already exist, the screen will look like this:



The top line is the **Status Line**. It contains the following information:

`c:filename.ext` This shows the name of the file you are editing.

`INS:ON` This shows whether character insert is on or off.

If insert is on, any text typed will be inserted at the cursor position and any text already present will move to make room.

With insert off, the display will show:
`INS:OFF`
In this case, typing will overwrite existing text.

`CAPS:OFF` This shows the state of the CAPS LOCK function.

Note: In CAPS LOCK mode, alphabetic keys type capitals unless used with ⇧, when they type lowercase letters. This is NOT a 'Shift Lock' function.

`COL:001` This shows the column of the virtual screen which the cursor is in. It is in the range 1 to 255. As the cursor moves, it is kept updated and may be used for aligning tables, indents in text, etc.

Column 1 is the left of the virtual screen. Column 255 is the extreme right of the virtual screen.

The bottom line is the **Function Line**. This shows the commands performed by pressing the function keys F1 to F10. F1 to F10 can be typed by using 1, 2 etc, using 0 for F10. F1 to F4 can also be typed by using the F1, F2, F3 and F4 keys next to the screen. These and the other editing functions are described later in this chapter. The function line is also used to display prompts and messages.

The lines between the status line and function line are called the Edit Area. The edit area displays the text you are working with. When you enter ED, if the file exists, you will see its first few lines in the edit area, like this:

c:filename.ext INS:OFF CAPS:OFF COL:001
Dear Sir,
With reference to your letter date+
Please amend your accounts accordi+
Yours faithfully,
Save Exit Find Repl Prnt Set View Dir

This is the display with line wrapping disabled and the 8x6 font, which shows only the first 39 characters of any lines which are wider than the LCD screen.

If you have specified the WRAP option, any lines which are longer than the width of the LCD will be continued on the next LCD line, like this:

c:filename.ext INS:OFF CAPS:OFF COL:001
Dear Sir,
With reference to your letter date+
d 1/10/89, I feel that I must point out+
that this invoice has already been pai+
d by our main accounts department, by p+
ost, on 15/10/89.
Save Exit Find Repl Prnt Set View Dir

The last column of the edit area contains characters which indicate the line length, as follows:

Character	Significance
<	no more data to right (ie all of the line is visible on this line of the LCD)
+	more data to the right (or on next screen line, if line wrapping is on)
B	line contains the block start marker (described later)
K	line contains the block end marker (described later)

If there is more data to the right, you can view it with line wrapping disabled by using the ⊖ key.

12.6 Facilities

Text is entered at the cursor position, which can be moved at will through the file. You can enter lines of up to 232 characters; if a line is longer than the width of the LCD, with wrapping enabled, it will simply continue on the next screen line.

To end a line, press ⏎. This is normally stored in the file as CR-LF (0DH, 0AH), but the LF option will make ED store it as the single character CR (0DH).

Remember that you're working with a temporary copy of the file: the disk is not updated until you use the SAVE command. This means that you can abandon any changes you have made by leaving ED without saving the file.

Commands are executed by typing certain keypad, function and control keys. These provide the following facilities:

Typing mode

CHARACTER INSERT	Switch between overtype mode (typed characters replace characters at the cursor) and insert mode (typed characters are inserted before text at the cursor)

Cursor movement

CURSOR KEYS	Move up/down/left/right a character/line at a time
WORD SKIP	Move left/right a word
TAB	Move right to the next tab stop (normally every 8 columns)
LINE START/END	Move to the start or end of the line

Screen movement

PAGE UP/DOWN	Scroll up/down a screenful
FILE START/END	Scroll to the start/end of the file

Searching

FIND	Move to the next occurrence of the specified text
REPLACE	Replace the next occurrence of the specified text

Deleting text

DELETE RIGHT	Delete the character at cursor
DELETE LEFT	Delete the character to the left of the cursor

WORD DELETE	Delete from cursor to the next word
DELETE LINE	Delete the current line
UNDELETE	Reverse the last simple delete operation (not BLOCK DELETE)

Block operations

BLOCK MARK	Define block start/end
BLOCK MOVE	Move marked block
BLOCK COPY	Copy marked block
BLOCK DELETE	Delete marked block
BLOCK WRITE	Write marked block to another file

File operations

SAVE	Save the file to disk and exit
EXIT	Exit without saving the file
READ FILE	Insert another disk file at cursor position
DELETE FILE	Delete a file
DIRECTORY	Display a directory listing

Printing

PRINT SCREEN	Print edit area to COM1
VIEW FILE	Display overview of file contents

Settings

COMMAND OPTIONS	Specify options in ED command (see section 12.4)
SET	Change settings from within ED

The words in capitals are the command names, which are used to identify the commands throughout this chapter. The keystrokes used to invoke the commands are summarised in section The commands. The commands are described in more detail in the remainder of this chapter.

ED only uses a small area of the CGA display, corresponding to the area of the LCD screen, so there is no point in using the viewing keys (◆←, ◆→, etc) to move the LCD window over the CGA as the rest of the CGA is blank; use the cursor and scrolling keys instead.

12.7 The commands

The editing facilities are invoked by typing special keys, as follows. Otherwise, the keyboard behaves exactly as described in section 7.4.

To interrupt most commands, press the Esc key. (The few exceptions are indicated in the individual command descriptions.)

12.7.1 Control Keys

You can type editing commands by using Control codes (Ctrl+A, Ctrl+B, etc), which are based on those used in the industry-standard wordprocessor WordStar:

Key	Command
Ctrl+A	Skip left
Ctrl+B	Not used
Ctrl+C	Page down
Ctrl+D	Cursor right
Ctrl+E	Cursor up
Ctrl+F	Skip right
Ctrl+G	Delete right
Ctrl+H	Delete left
Ctrl+I	TAB
Ctrl+J	Not used
Ctrl+K	Block commands
Ctrl+L	Not used
Ctrl+M	CR
Ctrl+N	Not used
Ctrl+O	Not used
Ctrl+P	Not used
Ctrl+QS	Line start
Ctrl+QD	Line end
Ctrl+R	Page up
Ctrl+S	Cursor left
Ctrl+T	Word delete
Ctrl+U	Undelete
Ctrl+V	Character insert
Ctrl+W	File start
Ctrl+X	Cursor down
Ctrl+Y	Line delete
Ctrl+Z	File end

12.7.2 Function Keys

The commands performed by the function keys (F1, F2 etc) are as follows.

Key	Command
F1 or F1	Save file
F2 or F2	Exit

Key	Command
F3 or 3	Find
F4 or 4	Replace
5	Print screen
6	Set
7	View file
8	Directory
9	Not used
0	Not used

Their functions are also indicated by legends on the bottom line of the screen (the Function Line).

12.7.3 Other Keys

A number of other keys also have special effects within ED:

Key	Command
Ins	Character insert
Clr	Delete left
Del	Delete right
PgUp+	Page up
PgDn+	Page down
Home	File start
End	File end

Note: Keys marked + are not available in the default keyboard.

BLOCK COPY

Form: Ctrl+KC

BLOCK COPY copies a block defined by using BLOCK START and BLOCK END, to the current cursor position.

This command does not affect the original block, except that the copy of the block is left marked.

You cannot copy a block into itself ie the cursor must not be within the block when you select the BLOCK COPY command.

If you attempt to copy a block when there is no block defined, you will see the following error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK DELETE

Form: Ctrl+KY

BLOCK DELETE deletes the block defined by using BLOCK START and BLOCK END.

BLOCK DELETE removes the block text and the block markers from the file. The cursor may be positioned within the block; its position is immaterial.

You cannot reverse a BLOCK DELETE by using the UNDELETE command.

If you attempt to delete a block when there is no block defined, you will see the following error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK MOVE

Form: Ctrl+KV

BLOCK MOVE moves the block defined by using BLOCK START and BLOCK END, to the current cursor position.

The block remains defined i.e. it is still marked.

You cannot move a block into itself i.e. the cursor must not be within the block when you select the BLOCK MOVE command.

If you attempt to move a block when there is no block defined, you will see the following error message:

```
No block marked... press any key
```

Press any key to carry on.

BLOCK START/END

Form: Ctrl+KB - BLOCK START
Ctrl+KD - BLOCK END

BLOCK START and BLOCK END are used to define a block of text so it can be moved, deleted, copied, or written using the other block commands.

The extent of the block is shown by reversing the text within it.

If you have defined the block start but not the block end, the block end is assumed to be the end of the current line (i.e. the next CR). To define a different end, use the BLOCK END command.

The start of a block is also indicated by a **B** in the last column of the screen; the end is marked by a **K**.

The start of a block must come before the end! If not, when you try to use the block, you will see the error message:

`No block marked... press any key`

Press any key to carry on.

BLOCK WRITE

Form: Ctrl+KW

BLOCK WRITE writes a copy of the block defined by using BLOCK START and BLOCK END, to a named file. It prompts you for the name by displaying:

`Write block file name>`

Type the filename to write to. ED will assume the extension .TXT if you do not type one. If you do not specify a drive or path, ED will write the file to the current drive and directory.

The block remains unaffected by use of BLOCK WRITE; it is not moved and is still marked. The saved file overwrites any existing file with the same name, without warning.

If you attempt to write a block when there is no block defined, you will see the following error message:

`No block marked... press any key`

Press any key to carry on.

CHARACTER INSERT

Form: **Ins** or Ctrl+V

CHARACTER INSERT switches between insert mode and overtype mode. The mode is shown on the top line. For example:

INS:ON

In overtype mode, characters entered replace (overtype) existing text.

In insert mode, text is inserted before the cursor position. This is useful for adding characters to the middle of a line.

There are two exceptions to the above rule: and the TAB command.

In overtype mode, simply moves the cursor to the beginning of the next line and TAB moves to the next tab stop (or inserts spaces, if at the end of a line). However, if the cursor is at the end of a line (i.e. a character), any characters typed will be inserted before the end of the line rather than overtyping it.

In insert mode, breaks the line at the cursor, while TAB inserts a Tab character or sufficient spaces to move to the next tab stop (depending on the use of the TAB option; see section 12.4).

Even in overtype mode, both keys will insert text if the cursor is at the end of the file.

CURSOR KEYS

Form: ↑ or Ctrl+E - CURSOR UP
↓ or Ctrl+X - CURSOR DOWN
← or Ctrl+S - CURSOR LEFT
→ or Ctrl+D - CURSOR RIGHT

These keys move the cursor a character or line at a time in the indicated direction. They may be used to move the cursor to any character within the text, where you can begin typing, deleting or other editing operations.

They cannot move the cursor to before the beginning of the file or after the end of the file, but can be used to move past the end of a line.

CURSOR LEFT will move to the end of the previous line if the cursor is at the start of the line. Similarly, CURSOR RIGHT will move to the start of the next line if the cursor is at the end of a line.

DELETE FILE

Form: Ctrl+KE

DELETE FILE deletes a file from the current or specified directory. It displays the prompt:

`Erase file>`

Type the filename, including a drive or path if required. If you simply type a filename, the current directory will be assumed.

To prevent the deletion, press Esc before the disk access.

DELETE LEFT/RIGHT

Form: Clr or Ctrl+H - DELETE LEFT
Del or Ctrl+G - DELETE RIGHT

DELETE LEFT deletes the character to the left of the cursor, then moves the cursor left.

DELETE RIGHT deletes the character under the cursor, without moving the cursor.

If you delete a ⏎, this will join that line with the next.

CAUTION: If you hold down a delete key, it will 'auto-repeat', storing delete commands, so that when you release the key, several more deletes will be performed. Do not hold a Delete key down. Instead, use single key depressions, LINE DELETE or BLOCK DELETE.

To insert the deleted text at the cursor, use UNDELETE.

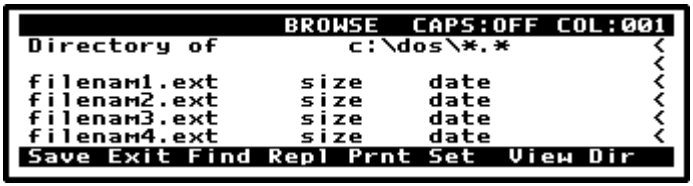
DIRECTORY

Form: 🐾8

DIRECTORY displays a directory of the current or specified drive and directory. It displays a prompt like this:

```
Directory>
```

To list the current directory just type ⏎. To list another directory, type its pathname, followed by ⏎. To list only certain files, use wildcards (see your MS-DOS manual). This displays a directory in the following form:



Use the PgUp or PgDn keys to scroll the directory. Press 🐾8 or 🐾2 to return to editing.

EXIT

Form: F2 or 2

EXIT quits ED. If you have not saved the file since making any changes, it displays the following prompt:

```
Exit editor (Y/N) ?
```

Press N to continue editing.

Press Y to leave the editor without saving the file. Note that if you do this, any changes you have made to an existing file will be lost; if you were creating a file, it will be lost entirely.

To save the text, use the SAVE command.

FILE START/END

Form: **Home** or Ctrl+W - FILE START
End or Ctrl+Z - FILE END

These commands move the cursor to the very beginning or end of the file.

FIND

Form: F3 or 3

FIND is used to search the file for a specified string. Searching starts from the cursor position and continues to the end of the file. To search the whole file, move to the start first (by using the FILE START command).

FIND displays the following prompt on the function line:

```
Find>
```

Or, if you have already specified a search string, it will be displayed for you to edit. Type the text to look for (up to 50 characters) or edit the displayed text, then press ⏎. Be exact, as FIND will only find an exact match (including use of spaces). Normally, FIND will consider capital and small

letters as different, but you can change this by using the **IGNORE** option in the ED command, or by using the SET command to select case-ignore. If the text is split over the end of a screen line FIND will still find it correctly.

While searching is in progress the following message will be displayed on the function line:

Searching...

If an exact match is found then the cursor is moved to its first character. If no match is found, the following message is displayed on the function line:

Search failed...

and the cursor remains where it was.

To halt the search, press Esc. To find and replace, use the REPLACE command.

LINE DELETE

Form: Ctrl+Y

LINE DELETE deletes the line on which the cursor is placed. The cursor can be anywhere within the line.

Note that LINE DELETE only deletes a single screen line. To delete an entire sentence or paragraph, you will probably need to use it several times.

LINE START/END

Form: Ctrl+QS - LINE START
Ctrl+QD - LINE END

These keys move the cursor to the beginning or end of the current line.

PAGE UP/DOWN

Form: PgUp or Ctrl+R - PAGE UP
PgDn or Ctrl+C - PAGE DOWN

These keys are used to scroll the text, a screenful (six lines) at a time. (This is quicker than using ↑ and ↓.)

If the cursor is not on the bottom screen line, PAGE DOWN will put it there. If the cursor is on the bottom line, PAGE DOWN will move the LCD screen six lines nearer the end of the file.

Similarly, PAGE UP will place the cursor on the top screen line, or move the LCD screen 6 lines nearer the start of the file.

These commands are useful for scanning quickly through files.

PRINT SCREEN

Form: 5

Prints the current contents of the screen to COM1.

READ FILE

Form: Ctrl+KR

READ FILE inserts a specified file at the cursor position, displaying the prompt **`Read block file name>`** Type the file name and press ↵.

READ FILE will normally read a file from the current directory. To read a file from a different directory include the drive and/or path before the filename.

If you do not specify an extension, .TXT will be assumed.

If the read fails for any reason (e.g. no such file or drive not ready), an error message will be displayed. Refer to section 12.8 for details.

REPLACE

Form: F4 or 4

REPLACE is used to search the file for a specified string and replace it with a second string. Searching starts from the cursor position and continues to the end of the file. To search the whole file, move to the start first (by using the FILE START command).

REPLACE displays the prompt **Find>**, followed by the previous search string if you have already used REPLACE or FIND. Type or edit the text to look for (up to 50 characters), and press ⏎. Be exact, as REPLACE will only find an exact match (including use of spaces).

Normally, REPLACE will consider capital and small letters as different, but you can change this by using the **IGNORE** option in the ED command, or by using the SET command to select case-ignore. If the text is split over the end of a screen line REPLACE will still find it correctly.

REPLACE then prompts for the replacement text with **Replace>**, followed by the previous replace string if you have already used REPLACE. Type or edit the string (up to 50 characters) and press ⏎ to begin searching.

While searching is in progress, **Searching...** will be displayed on the function line. If an exact match is found then the found string is replaced by the replacement string cursor and the cursor is moved to its first character.

If no match is found, **Replace failed...** is displayed on the function line and the cursor remains where it was.

To halt the search, press Esc. To search without replacing, use the FIND command.

SAVE

Form: F1 or 1

SAVE saves the text to a disk file. It displays the prompt **File name>** followed by the filename specified in the ED command or a previous SAVE command. To save the file with this name, just press ↵. To save it with a different name, edit the displayed name and then press ↵. Note that if you do not specify a path, this will save the file to the current directory.

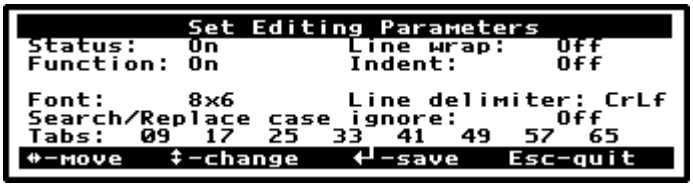
If you do not specify an extension, .TXT will be assumed.

If the save fails for any reason (e.g. disk full or file is read-only), an error message will be displayed. See section 12.8 for details.

SET

Form: 6

This command can be used to examine or change the optional settings which change the behaviour of ED. It displays a menu like this:



To change a setting, press ← or → to move to it, then press ↑ or ↓ until the setting is correct.

When you have finished, press ↵ to use the changed settings, or Esc to ignore them.

The options are as follows:

Status	Use the top line for a status display (On) or for text (Off). The default is On.
Function	Use the bottom line for function key display (On) or for text (Off). The default is On.
Line wrap	Display just the first 39 (8x6 font) or 59 (6x4 font) characters of each line (Off) or wrap each line onto the next screen LCD line (On). The default is Off.
Indent	Move the cursor to column 1 each time is pressed (Off) or to a specified column (1..9) if in insert mode. The default is Off.
Font	Use the standard text font (8x6) to display 8 lines of 40 characters or use the compressed font (6x4) for 10 lines of 60 characters. The default is 8x6.
Line delimiter	When you press , place a CR character or a CR plus LF in the file.
Search/Replace case ignore	Require an exact match (Off) or ignore case (On) for SEARCH and REPLACE functions. The default is Off.
Tabs	Defines the 8 tab stops that are used when you press the TAB key (Ctrl+I). Tab stops are initially set every 8 columns (ie 9, 17, 25, 33 etc).

Notes

You can also specify the line wrap, font, line delimiter and case ignore settings by using ED command line options (see section 12.4).

If you have already used TABs in the file, changing the tab settings will move any TABs which were entered as TAB characters, but will have no effect on TABs which were entered as spaces. (See the description of the TAB command for more details.)

TAB

Form: Ctrl+I

TAB moves the cursor to the next tab stop, making it easier to indent text and lay out tables. Tab stops are normally set every 8 characters ie at column 9, 17, 25, etc, but you can change the spacing by using the SET command. (If there is no tab stop to the right of the cursor, the cursor will not move.)

The way that TAB moves the cursor depends on the typing mode and use of the TAB option in the ED command.

- In insert mode, TAB normally inserts sufficient spaces to move the cursor (and text to the right of the cursor) to the next tab stop on the current line. However, if tabs have been turned on by using the TAB option in the ED command (see section 12.4), TAB will simply insert a TAB character (ASCII 09H), which moves the cursor and text to the next tab stop.

- In overtype mode, TAB normally simply moves the cursor to the next tab position on the current line without moving the text or inserting anything in the file, but it will insert sufficient TAB characters or spaces (depending on use of the TAB option) to move to the next tab stop if that is beyond the current line end.

TABs inserted as TAB characters will move if the tab stops are moved by using the SET command. TABs inserted as spaces will not move.

Another way to indent text is to use the indent option provided by the SET command.

UNDELETE

Form: Ctrl+U

Inserts the text deleted by the previous DELETE LEFT, DELETE RIGHT, LINE DELETE or WORD DELETE command. This will reverse the effect of the command if the cursor is in the same place.

UNDELETE simply inserts the text deleted by the previous delete command. It will NOT reverse a BLOCK DELETE command.

VIEW FILE

Form: 7

VIEW FILE tells ED to 'zoom' the LCD, to show a graphics representation of the file contents starting from the current LCD screen position, like this:

This shows each non-space character as one black plus one white pixel, and each space character as two white pixels, allowing the LCD to represent up to 120 characters per line (if a line is longer than this, the excess characters are not displayed.) Each line of pixels is separated from the next by a blank line, so the LCD can show the contents of 32 text lines.

In VIEW FILE mode, you cannot use any other commands. To return to the normal view and continue editing, press Esc or ←.

WORD DELETE

Form: Ctrl+T

WORD DELETE deletes from the cursor to the start of the next word. To insert the deleted text at the cursor position, use UNDELETE.

WORD SKIP

Form: Ctrl+A - SKIP LEFT
Ctrl+F - SKIP RIGHT

SKIP RIGHT moves the cursor to the start of the next word, while SKIP LEFT moves the cursor to the start of the previous word.

These keys provide a quick way to move around text.

12.8 Error Messages

The simplest error message is:

beep

You have typed an illegal answer to a prompt, or used a command when it is not valid, such as deleting when in BROWSE mode, or typed an unrecognised command, such as Ctrl+B.

ED displays error messages on the last line. They are as follows:

Browse mode only
You have attempted to edit a file after loading it with the browse option (**/BROWSE**). If you want to edit it, EXIT, then repeat the ED command but without the **/BROWSE** option.

Copy invalid: cursor within block
You have tried to copy a block into itself. Move the cursor outside the block and try again.

Disk full... file truncated
There was not enough room to fit the whole file on the specified disk, so only part of it has been written. If you want to save the whole file, either use another disk, or delete some files first (using DELETE FILE).

Disk read failed
ED could not read the disk; it may be corrupt or not ready.

Disk read incomplete- file too big
There is insufficient room in memory to load the entire specified file, so as much as would fit into memory has been loaded. You may now edit this part of the file as long as your edits do not increase its size, but when you SAVE it, specify a new filename or you will overwrite the original file, losing that part which did not load. (To load the entire file, try increasing the free DOS memory, for example by reducing the BUFFERS or FILES parameters in CONFIG.SYS and rebooting.)

Disk write failed
ED could not write to the disk. For example, there may already be a write-protected file with the specified name, or the drive may not be ready. Press Esc to abort the command and continue using ED.

File not found
ED could not find the file specified in the ED command. EXIT, then check your typing. Remember that the filename must come before any options.

Filename contains invalid chars
Self-explanatory. Refer to your MS-DOS manual for full details of file names.

Invalid directory path
Self-explanatory. Refer to your MS-DOS manual for full details of path names.

Invalid filename
Self-explanatory. Refer to your MS-DOS manual for full details of file names.

Invalid option
You have included an option in an ED command which is not one of those specified in section 12.4. Remember that options come after the filename and must be separated by / characters.

Move invalid: cursor within block
You have tried to move a block into itself. Move the cursor outside the block and try again.

No block marked... press any key
You have tried to use a block command (BLOCK COPY, MOVE, DELETE or WRITE) but have not defined the block. Press any key to continue. Use BLOCK START and BLOCK END to define the block.

No files found
You have specified a pathname in the DIRECTORY command that does not match any files.

Replace failed...
ED could not find the specified text in the file, or there was insufficient room in memory to make the replacement. Remember that searching starts at the cursor position and the specified text must match exactly. If you think the problem may be with capitalisation, use the case-ignore option (SET command).

Search failed...
ED could not find the specified text in the file. Remember that searching starts at the cursor position and the specified text must match exactly. If you

think the problem may be with capitalisation, use the case-ignore option (SET command).

Searching...
This is not an error message; it simply indicates that ED is searching for the specified text.

Short of memory- save file NOW!
There is no room in memory for any more text. If you can, make more room by deleting some text. If you wish to add more text, you must split the file in two (using BLOCK WRITE), then load and edit each half separately. If this is not possible, you must save the file (SAVE command), increase the free DOS memory (for example by reducing the BUFFERS or FILES parameters in CONFIG.SYS and rebooting).

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13. Introduction to Communications

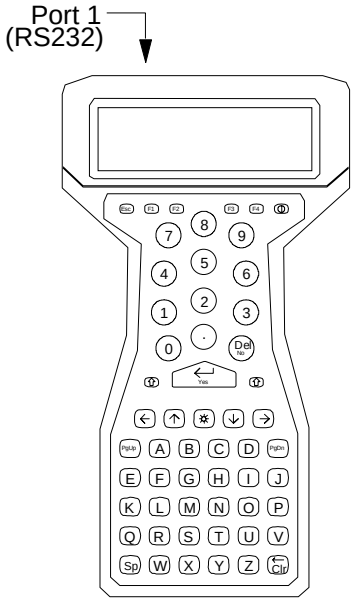
This chapter provides an introduction to communications and serial interfacing, and practical information on selecting the protocol, handshaking, cabling and other aspects of setting up the serial port.

For information on using communications, see Chapter 14. For details of programming with communications, see Part 3. For more details of the communications options available, see Chapter 15 or contact your supplier.

13.1 Introduction

Communications facilities are especially important for portable computers, because they often rely on communications to exchange information or programs with remote computer systems.

The **MP2500** is equipped as standard with a single industry-standard RS232/V24 serial port (Port 1), permanently assigned as COM2.



The Port 1 serial port conforms in general with the RS232/V24 specification, which is used for serial interfaces in virtually every computer system, terminal, printer and modem. This allows you to 'plug in' to most other systems usually without modification, including microcomputer systems such as the IBM-PC.

The **MP2500** will normally be used as a self-contained computer, with the communications port being used to connect suitable peripherals such as wands, printers or modems. However, the port may also be used to connect to a host computer system, allowing you to use the **MP2500** as a portable terminal.

An **MP2500** can also communicate with another **MP2500** or other **HUSKY** computers, either side-by-side on the bench or over long distances by telecommunication channels.

Note: In this chapter, 'host' is used to refer to the system that is communicating with the **MP2500**. It will typically be another computer, modem or terminal.

13.2 Communications packages

The **MP2500** has been designed to closely resemble IBM PC hardware, to give you access to the range of software available for that computer. This includes the serial ports and communications.

HUSKY provide a communications package, which you can select when appropriate, that has the following major advantages:

- Support for protocols (XON/XOFF and any optional protocols installed), providing more secure data transfer.
- Configurable handshaking, to suit a wide variety of devices and connection methods.
- Faster data transfer (up to 38,400 Baud) for efficient communications.
- Data buffering for reliable fast transfer.
- Compatibility with other **HUSKY** handheld computers (such as the **HUSKY FS/2** and **HUSKY FS3**).

This chapter is mainly concerned with setting up and using these **MP2500** facilities. For more details of standard IBM PC communications, refer to any standard MS-DOS user's or programmer's guide.

The **MP2500** is provided with a built-in file transfer utility called HCOM.COM and an XMODEM file loader called XL.COM. For details, see Chapter 14. Alternatively, in many cases you will be able to use a third party communications package, providing it will operate on IBM PC-compatible hardware. In this case, **MP2500** communications will be completely ignored; the package will use the serial ports as it would on an IBM PC.

13.3 Background information

You do not need a detailed understanding of data communications to use the powerful facilities. You simply need to know how to:

- Connect to the remote system.
- Set up the **MP2500** communications to suit the remote system.
- Use the communications facilities provided.

The following sections assume that you are using the **MP2500** serial communications port.

13.3.1 Buffering

Port 1 is interfaced via a 16450 UART, without any on-chip buffering.

MP2500 communications provides data buffering via invisible 'buffers' that effectively disconnect the application program from the outside world. The communications package is driven by interrupts, for maximum efficiency. This ensures a smooth flow of data and correct handling of communications even when the **MP2500** is busy doing something quite different!

Because the communication package is interrupt driven, the execution of user programs is generally not affected by communications. However, the user program may slow down if the serial line is busy. The buffers are available whenever the machine is powered up, even if the application program is not requesting communication. Incoming messages will be received and held in the buffer, while any outgoing data remaining will

continue to be sent down the line. Any protocols selected will continue to be observed.

13.3.2 Data Transmission

While using **MP2500** communications, transmitted data is initially written to a 256 character transmit buffer. Characters are removed from this buffer by the interrupt-driven communications package as and when the remote system is ready to receive them.

If the buffer becomes full, then the application is held up until the characters are sent (or a timeout occurs).

If a timeout or other communications failure is detected, it is reported and execution of the user program is suspended until the user acknowledges the error.

13.3.3 Data Reception

While using **MP2500** communications, received data is placed initially in a 256 character wrap-round receive buffer.

If the buffer becomes full, the protocol or handshaking which have been selected should prevent reception of further data. However, if the remote system does not stop transmitting when requested to (ie does not respond correctly to the protocol or handshaking selected), the later characters overwrite the earlier characters.

An application reads data from this receive buffer. If there is sufficient data in the buffer, then it will be returned immediately. If there is insufficient data, the **MP2500** will wait for it to arrive (or until a timeout occurs).

Reception of data is completely transparent to the application being run. Data may be sent at any time and the communications protocols will function as configured.

If a timeout or other communications failure is detected, execution of the user program will be suspended until the user acknowledges the error. (See section 14.11.)

13.4 Connecting up

The **MP2500** is provided with one 9-way D-type. You can connect or disconnect at any time: you do not need to power down first.

Note: Never try to force a mating connector home. Check that the connector is correctly aligned. If it won't fit easily, check for orientation or damage.

Standard cable are available from **HUSKY.** If you wish to make your own cables, refer to Appendix F for pinouts and section 13.7 for example cables you'll need to connect to the most popular computers and peripherals and information on complying with EMC and FCC legislation.

Remember that if you are using **MP2500** communications, the behaviour of the handshaking lines is configured by the UTIL utility (or the application you are using). See section 10.1.5.

13.5 Configuring MP2500 communications

When you reboot (or turn on for the first time), the default **HUSKY MP2500** communications is selected, with the following settings:

Speed:	2400	Null:	00	Echo:	No
Protocol:	None	CTS:	No	Txt/o:	Off
Length:	8	RTS:	Off	Rxt/o:	Off
Parity:	None	DTR:	No	Serig:	Off
Stop:	1	DSR:	No		
Lf:	No	DCD:	No	**HUSKY** Mode: **(See Note below)**	Yes

Note that this is referred to as **HUSKY FS3 mode**, and the term **FS3 mode** is used on the **MP2500** setup screens (see section 10.1.5). **HUSKY MP2500** and **FS3** share the same configuration utilities.

To use IBM communications, you or the application must select it first. See section 10.1.5 for details of selecting IBM communications via the UTIL function; see Part 3 for details of selecting IBM communications from an application.

If you are using an application written especially for the **MP2500**, it should select and configure communications automatically. In this case, you won't be required to intervene.

However, an application might present a menu for you to select from. In this case, once you've selected the mode you require, it will configure communications without further action.

If you want to use **MP2500** communications from MS-DOS or with an application that doesn't provide its own communications handling, you must configure communications first, by using the UTIL utility.

To do this, select MS-DOS command mode and type:

C:\UTIL ⏎

then select the appropriate communications menu option. This displays the current configuration for the port. Use the ← and → keys to move the highlight to the options you want to alter, then use ↑ and ↓ to adjust the displayed value as required.

When you have finished, press ⏎ to accept the settings and return to the previous menu. Press Esc to return to MS-DOS command mode with the **MP2500** communications package installed and configured as you have requested.

If you have installed one of the more complex optional protocols, an extra menu screen will be displayed for you to configure. Full details will be supplied with the protocol.

If you simply want to examine the configuration, press Esc without using the cursor keys.

The individual options will now be described, after a brief overview of handshaking and protocols. For details of the operation of UTIL, refer to Chapter 10.

13.5.1 Handshaking

While you do not need to know how handshaking works in order to use **MP2500** communications, you may find the following of interest.

Handshaking is a form of control provided by adding extra wires between the two communicating systems. These allow the two systems to communicate information such as 'I am ready to transmit' or 'I am ready for another character'.

Each handshaking signal is carried by a different wire and has a different name (CTS, RTS, DTR, etc). These names are often used interchangeably for the signal and for the wire or pin carrying it.

Port 1 (COM2) includes a number of handshaking lines which conform to the standard RS232 specification for use with modems, and may be configured to suit particular requirements.

Handshaking is usually used when operating with a modem, but may also be used when communicating with slow devices (such as printers) which are connected direct to the **MP2500**, or to allow the **MP2500** to suspend data transmissions to it.

As handshaking involves extra wires, it cannot be used over normal telephone lines, to control the remote system. Instead, handshaking is used to control the modem which connects the **MP2500** to the telephone line. (A control mechanism similar to handshaking can be achieved by using a protocol, which includes control messages with the data being transmitted. See section 13.5.2.)

You can change the way the **MP2500** produces and reacts to handshaking signals from applications or the UTIL utility. This makes communications rather easier than with systems which have fixed handshaking (with these, you often need to produce custom cables to 'trick' handshaking).

The individual handshaking lines are described in turn later in this chapter, with the single exception of Ring Indicator (RI). RI is an input which will turn the **MP2500** on. It is often used by an auto-answer modem, to turn the **MP2500** on when a call is received so it can process the call.

13.5.2 Protocols

While you do not need to understand how protocols work in order to use communications, you may find the following information of interest.

Communications protocols are standard ways of organising data for transmission, controlling transmission, detecting and handling errors.

A protocol transmits control information along the same path as used for data. Since it does not use extra wires, a protocol can be used over standard telephone lines, unlike handshaking.

Just like other configuration details, the protocols used on transmitter and receiver must be the same.

The following protocols are provided as standard:

- XON/XOFF
- NONE

The NONE protocol is suitable for transferring ASCII (7-bit) or binary (8-bit) data; XON/XOFF is only suitable for ASCII data.

These protocols will now be described in turn.

13.5.2.1 NONE

Reception

As its name implies, this selection does nothing to control the incoming data; transmission will normally be controlled by handshaking. The serial interface behaves like a simple Teletype. Characters are placed in the receive buffer when they are received, then removed when the application requests serial input.

If there is no room in the receive buffer, received characters will overwrite previously received characters. (This would normally be prevented by handshaking with the remote system.)

Transmission

Each character sent by the application is placed in the transmit buffer (if there is room). Characters are then removed and transmitted when the remote system is ready for them. Transmission would normally be controlled by handshaking.

If there is no room in the transmit buffer, the application will be made to wait for room.

13.5.2.2 XON/XOFF

Reception

If an incoming character causes the receive buffer to have 240 or more unread characters, the **MP2500** transmits an XOFF character (DC3, 13H or Control-S), which should prevent the host sending further characters. When there are only 100 characters left unread in the buffer, the **MP2500** sends an XON character (DC1, 11H or Control-Q), which should tell the host to carry on transmitting.

Once the **MP2500** has sent an XOFF, it continues sending them every three seconds until it is ready for more data. It then sends XONs every three seconds until it receives more data. (This helps make sure that flow is controlled correctly, even if the host misses the first XON or XOFF.)

Transmission

While transmitting, the **MP2500** continuously examines its input data line for XON or XOFF characters sent by the host.

If an XOFF or stream of XOFFs are received, the **MP2500** stops transmitting as soon as the character being transmitted is finished. It will only restart transmission when it receives an XON from the host.

By the very nature of this protocol, indeterminate handshaking situations may occur if any conditions are altered during transmission.

Note: When the host sends an XOFF, the **MP2500** may send up to two more characters, depending on data link speed. This is due to the time taken to receive the XOFF and the possibility of just missing the start of the next character.

The host does not need to send an XON at the start of transmission.

13.5.3 Port set-up options

The port set-up options will now be described, in alphabetical order.

CTS

Use

To control the response to the CTS (Clear To Send) handshake input while transmitting on COM2.

Notes

Setting	Result
Yes	The **MP2500** will only transmit data if CTS is active (positive). CTS is tested at the start of each character. If CTS goes inactive part way through transmitting a character, that character will be completed before transmission stops.
No	CTS is ignored.

DCD

Use

To control the response to the DCD (Data Carrier Detect) handshake input on COM2.

Notes

Setting	Result
Yes	The **MP2500** will receive data normally only while DCD is active (positive).
No	DCD is ignored.

DSR

Use

To control the response to the DSR (Data Set Ready) handshake input on COM2, while transmitting or receiving.

Notes

The connected device (usually a modem) can use this signal to tell the **MP2500** when it is ready to operate.

Setting	Result
Yes	The **MP2500** will transmit or receive only while DSR is active (positive).
No	DSR is ignored.

DTR

Use

To control production of the DTR (Data Terminal Ready) handshake output on COM2, while transmitting or receiving.

Notes

This signal is provided to allow you to use auto-answer modems that require DTR to be present before generating carrier.

Setting	Result
Yes	DTR goes active (positive) when the **MP2500** is ready to receive or transmit.
No	DTR remains inactive.
On	DTR permanently on.

ECHO

Use

To control whether characters will be displayed on the screen as they are transmitted.

Notes

Data transmission and reception are not affected by echoing and the displayed characters are not passed to user programs or entered in the receive buffer.

ECHO is usually used to mimic full duplex operation with a half duplex remote system. If the remote system is operating in full duplex mode, selecting ECHO will display each character twice!

Setting	Result
Yes	Characters are echoed as they are transmitted.
No	Characters are not echoed.

Echoing a non-text file is not recommended.

FS3 MODE

Use

To select IBM or **FS3** (**HUSKY**) communications.

Notes

See section 10.1.6 and 13.3 for information on **FS3** and IBM communications modes.

LENGTH

Use

To set the number of data bits transmitted or expected when receiving.

Notes

Setting	Result
7	Seven data bits
8	Eight data bits

Note: If transmitting binary files, set LENGTH to 8.

Note that you cannot select 5-bit or 6-bit data lengths from UTIL, although the IBM PC supports these (can be selected by direct programming of the UART). This is unlikely to cause problems, as these data lengths are very rarely used.

LF

Use

To control automatic transmission of a LF character (decimal 10, hexadecimal 0AH) after each CR (decimal 13, hexadecimal 0DH) when transmitting.

Notes

This option is mainly provided for use with printers or other remote systems that require an LF after a CR to start a new line.

Setting	Result
Yes	A LF will be inserted after each CR transmitted, even if there is already a LF in the text.
No	Extra LFs will not be inserted, although any LFs in the data will be transmitted as normal.

Note: When sending binary data (such as a machine code program), set LF to No to avoid corrupting the data.

Also note that with LF on, you are adding characters to the transmitted data, so the length will be greater and mechanisms such as checksums will be misled.

NULL

Use

To control whether the **MP2500** inserts NULL characters (decimal 0, hexadecimal 00H) after each CR, when transmitting.

Notes

This option is mainly provided for use with printers that take a significant time to perform a Carriage Return operation and don't have handshaking or buffering. NULLs are not printed, they simply give the printer time to perform the CR function.

Setting	Result
0	No NULLs are added.
1..20	1..20 NULLs are added.

If LF is set to 'y', any NULLs will be sent after the CR LF sequence.

Note: If transmitting binary files, set NULL to 0 to avoid corrupting the data.

PARITY

Use

To select the data parity to add to transmitted data, and the data parity checking that will be used to check received data.

Fixed parities (Mark and Space) can be selected by directly programming the UART.

Notes

When transmitting, PARITY has the following significance:

Setting	Result
None	A parity bit is not added.
Odd	A parity bit of 0 or 1 is added to produce an odd number of logical 1's in the data bits.
Even	A parity bit of 0 or 1 is added to produce an even number of logical 1's in the data bits.

When receiving, PTY has the following significance:

Setting	Result
None	A parity bit is not expected. If parity bits are sent, they will produce data framing errors.
Odd	The data is checked for an odd number of logical 1's (including the parity bit). If the check succeeds, the character is returned to the calling program. If the check fails, the character is not returned and a parity error is flagged.
Even	The data is checked for an even number of logical 1's (including the parity bit). If the check succeeds, the character is returned to the calling program. If the check fails then the character is not returned and a parity error is flagged.

Parity errors on receive may be ignored, display a communications error message (see section 14.11), or be handled by your application (see Part 3).

Note that the **MP2500** does not support a fixed parity of 1, unlike the IBM PC. This is unlikely to cause problems as fixed parity is very rarely used.

PROTOCOL

Use

To select the protocol to use for communications.

Notes

The standard protocols available are: NONE and XON/XOFF.

Other protocols may also be available, if they have been installed. Selecting one of these more complex protocols will display an extra menu screen, which you must use to configure it. See section 13.5.2 for further details of these protocols.

RTS

Use

To control production of the RTS (Request To Send) handshake output on COM2, while transmitting or receiving data.

Notes

The **MP2500** uses this signal either to tell a remote device that is ready to send data, or to prevent further reception when its receive buffer is full.

Setting	Result
OFF	The RTS line is permanently active (positive).
HOLD	The RTS line is normally active (positive) and only goes inactive (negative) when the receive buffer is full. This allows the **MP2500** to hold up a transmitting device (by lowering the RTS line) until it has removed enough characters from the receive buffer to allow the transmitting device to send more data (by raising the RTS line again). This mode can be used when communicating with another **HUSKY** computer, via a crossed cable. Normally, RTS would be connected to the transmitting device's CTS input.
TRUE	This mode is mainly used with a half duplex modem or similar device, when sending data in blocks and relying on the protocol for flow control. When the **MP2500** is ready to transmit data, it raises RTS to active (positive), then waits for a reply on the CTS line (if enabled) before sending the data in the transmit buffer. RTS remains active until all the data has been sent and the buffer is empty, then the **MP2500** returns RTS to the inactive state (negative).

RX T/O

Use

To set the timeout period for data reception.

Notes

The timeout is initiated by a request for serial input by an application. If a character is not read from the receive buffer within the specified time limit (because it is empty), a communications error will result.

Reception of any character, or noise, will reset the timeout.

Note that if no attempt is made to read the input communications buffer, this timeout will not occur.

Setting	Result
Off	No timeout
1..60	Timeout after 1 to 60 seconds

Note: If an optional protocol is being used which has its own timeouts, disable the timeout.

SERIG (Serial Ignore Character)

Use

To filter a particular character from received data.

Notes

This tells the **MP2500** to remove a particular ASCII character from serial input i.e. to receive it normally but not place it in the receive buffer, so the character is never passed to the application.

This option is provided for use with computer systems that transmit abundant spurious characters (such as NULL, LF, XON or DEL) along with the real data. To save the application having to filter these unwanted characters, use SERIG.

Setting	Result
0-127	Filter the specified ASCII code from received data.
Off	Do not filter any characters.

To set SERIG to Off, increment past 127 or decrement past 0.

Note: Set SERIG to Off with binary data or protocols other than NONE or XON/XOFF.

SPEED

Use

To set the transmit and receive Baud rates (speeds) to suit the connected device.

Notes

The Baud rates available are: 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400

Note that external devices, the communications channel, or the application may not be able to handle the highest Baud rates.

STOP

Use

To set the number of stop bits transmitted.

Notes

Setting	Result
2	2 stop bits.
1	1 stop bit.

TX T/O

Use

To set the timeout period for data transmission.

Notes

The timeout is initiated by a request for serial output by an application. If the application fails to put a character in the transmit buffer (because it is full) within the specified time limit, a communications error will occur.

If no attempt is made to transmit data, this timeout will not occur.

Setting	Result
Off	No timeout.
1..60	Timeout after 1 to 60 seconds.

Note: If an optional protocol is being used which has its own timeouts, disable the TX timeout.

13.6 Configuring IBM communications

Standard IBM communications will be selected by any standard application or command that initialises communications. The default COM2 configuration is as follows:

Speed:	2400
Data bits:	8
Parity:	No
Stop bits:	1
Retry on timeout:	No

(All handshake lines are inactive and interrupts are disabled.)

You can alter all these settings from MS-DOS command mode, by using the standard MS-DOS MODE utility. For example, to select 4800 Baud, 8 data bits, odd parity, 1 stop bit and no timeout for COM2, type:

`MODE COM2 48,O,8,1,P` ⏎

Note that the following IBM PC-compatible settings are not supported:

Data bits: 5, 6
Parity: 1 (fixed)
Stop bits: 1.5

These limitations are unlikely to affect you in practice, as these settings are very rarely used.

Note: For details of the MODE utility, refer to any standard MS-DOS user's guide.

13.7 Example communications set-up

This section describes the cables and configurations you will need to connect the serial port, Port 1 (COM2) to a number of popular devices, in order to transfer binary or ASCII (text) data. The cable details assume that the **MP2500** is fitted with the standard 9-way D-type connector.

Note: Cable connections given below are for guidance only. To comply with EMC and FCC legislation, all cables must be shielded, with grounded metal connector shells. You are advised to always use communications cables supplied by **HUSKY**.

13.7.1 Communicating with another MP2500 (or an FS unit with a 9-way D-type)

13.7.1.1 Cable

To connect Port 1 on one **MP2500** direct to Port 1 on another, you need a simple 'crossed cable'. For example, assuming they both use 9-way connectors:

First **MP2500** (9-way male)		Second **MP2500** (or FS unit) (12-way male)
2	----------	3
3	----------	2
5	----------	5
7	----------	8
8	----------	7

13.7.1.2 Configuration

As the two computers are connected together by a short cable, you can use the fastest speed available, simple CTS/RTS handshaking and parity checking. There is no need for a protocol, as the handshaking controls data flow and parity checking provides reasonable security.

Configure each unit as follows:

Option	Setting	Comments
Baud rate:	38400	As fast as you can, to save time.
Protocol:	None	None needed.
Length:	8	Binary data.
Parity:	Even	Allows data integrity checking
Stop bits:	1	Minimum required to save time.
LF:	No	Adding LFs would corrupt binary data.
Null:	0	Adding NULLs would corrupt binary data.
RTS:	Hold	Handshake output when receiving and no more room. (Connected to transmitter's CTS.)
DTR:	No	Not needed.
CTS:	Yes	Handshake input when transmitting, allowing transmission to proceed. (Connected to receiver's RTS.)
DSR:	No	Not needed.
DCD:	No	Not needed.
Echo:	No	There's no point viewing binary data!
Txt/o:	30	As there's a direct connection, you only need a short timeout, but a longer time makes operation easier.
Rxt/o:	10	A fairly short timeout, as this is used to indicate the end of the received file.
Serig:	off	Filtering bytes would corrupt binary data.

13.7.2 Communicating with an FS unit equipped with 12-way (circular) connectors

13.7.2.1 Cable

To connect Port 1 on the **MP2500** to the FS unit, you need a cable like this, assuming 12-way connectors on the FS unit:

MP2500 (9-way male)		FS unit (12-way female)
2	----------	B
3	----------	C
5	----------	G
7	----------	E
8	----------	D

13.7.2.2 Configuration

Configure the two computers as described in section 13.7.1.

13.7.3 Communicating with an external modem

13.7.3.1 Cable

Most modems are configured as DCEs, so you can use a cable like this to connect to the **MP2500**'s 9-way connector:

MP2500 (9-way male)		Modem (25-way)
2	----------	3
3	----------	2
5	----------	7
7	----------	4
8	----------	5

13.7.3.2 Configuration

You must configure the handshaking and data format to suit the modem, but select a protocol to suit the remote computer.

For example, to suit a typical modem, configure the **MP2500** as follows:

Option	Setting	Comments
Baud rate:	*	To suit the modem.
Protocol:	*	To suit the remote system.
Length:	8	Binary data.
Parity:	*	To suit the modem.
Stop bits:	*	To suit the modem.
LF:	No	Adding LFs would corrupt binary data.
Null:	0	Adding NULLs would corrupt binary data.
RTS:	True	Handshake output when the **MP2500** wants to start transmission. (Modem replies on CTS.)
DTR:	Yes	May be needed to turn on the modem.
CTS:	Yes	Handshake input from the modem, when the modem asks to start transmitting (by raising RTS).
DSR:	Yes	Input to indicate that the modem is ready to operate.
DCD:	Yes	Input to indicate that received data is valid.
Echo:	No	There's no point viewing binary data!
Txt/o:	30	To help detect any problem between the **MP2500** and the modem.
Rxt/o:	30	To help detect any problem between the **MP2500** and the modem.
Serig:	off	Filtering bytes would corrupt binary data.

Configure the modem interface speed, parity, data and stop bits as the **MP2500**. Configure the modem line speed to suit the remote modem.

13.7.4 Communicating with a PC (Personal Computer) - serial communications

13.7.4.1 Cable (25-way)

Some PCs have a 25-way D-type connector fitted, usually female but sometimes male. If a 25-way connector is fitted, you will require a cable wired as shown below.

MP2500 (9-way male)		PC (25-way female or male)
2	----------	2
3	----------	3
4	----------	6
5	----------	7
6	----------	20
7	----------	5
8	----------	4

If a 9-way connector is fitted, you will require a cable wired as shown in the next section.

13.7.4.2 Cable (9-way)

Most PCs are fitted with 9-way D-type sockets, for which you will require a cable like this:

MP2500 (9-way male)		PC (9-way female or male)
2	----------	3
3	----------	2
4	----------	6
5	----------	5
6	----------	4
7	----------	8
8	----------	7

13.7.4.3 Configuration

Configure the **MP2500** as follows:

Option	Setting	Comments
Baud rate:	9600	As fast as the PC can go.
Protocol:	None	None needed.
Length:	8	Binary data.
Parity:	Even	Allows data integrity checking
Stop bits:	1	Minimum required to save time.
LF:	No	Adding LFs would corrupt binary data.
Null:	0	Adding NULLs would corrupt binary data.
RTS:	Hold	Handshake output when receiving and no more room. (Connected to transmitter's CTS.)
DTR:	No	Not needed.
CTS:	Yes	Handshake input when transmitting, allowing transmission to proceed. (Connected to receiver's RTS).
DSR:	No	Not needed.
DCD:	No	Not needed.
Echo:	No	There's no point viewing binary data!
Txt/o:	0	Not needed, but could be set to 30.
Rxt/o:	0	Not needed, but could be set to 30.
Serig:	off	Filtering bytes would corrupt binary data.

Configure the PC as follows:

Option	Setting
Speed:	9600
Data bits:	8
Parity:	E
Stop bits:	1
Retry on timeout:	No

13.7.5 Communicating with a serial printer

13.7.5.1 Cable

To connect to a serial printer, you'll need a simple 'crossed cable':

MP2500		Printer
2	----------	2
3	----------	3
5	----------	7
7	----------	5
8	----------	4

Printers usually don't transmit data back to the computer (unless using the XON/XOFF protocol), so you may not need to connect the printer's TXD and CTS pins (pin 2 and pin 5). If you are willing to use a slow Baud rate, you may even be able to dispense with all handshaking and use the following 2-wire cable:

MP2500		Printer
3	----------	3
5	----------	7

If you do this, you must also turn CTS handshaking off on the **MP2500** (ie set the CTS option to No, using UTIL).

13.7.5.2 Configuration

As the printer is connected by a short cable, you can use the fastest speed available and simple CTS/RTS handshaking.

To show some of the versatility provided by configurable communications, assume that the printer does not have a buffer, perform a LF automatically when it receives a CR character, or handshake properly, but does support the XON/XOFF protocol.

Configure the **MP2500** as follows:

Option	Setting	Comments
Baud rate:	*	Set to suit printer. (As fast as you can, to save time.)
Protocol:	XON/XOFF	Used to supplement handshaking.
Length:	7	ASCII data.
Parity:	*	Set to suit printer.
Stop bits:	*	Set to suit printer.
LF:	Yes	Add LFs after CRs to make the printer advance the paper correctly.
Null:	20	Needed to give printer time to perform CR LF.
RTS:	-	Irrelevant.
DTR:	No	Not needed.
CTS:	Yes	Handshake input when transmitting, allowing transmission to proceed. (Connected to printer's RTS.)
DSR:	No	Not needed.
DCD:	No	Not needed.
Echo:	Yes	To monitor progress.
Txt/o:	1	This timeout will allow you to monitor problems such as paper out or off-line.
Rxt/o:	-	Irrelevant as printers don't usually transmit data.
Serig:	off	Irrelevant.

Configure the printer as follows:

- With the 5-wire cable (TxD, RxD, CTS, RTS, 0Volt): Set the baud rate, parity, data bits and speed as set on the **MP2500**, and select the XON/XOFF protocol.

- With the simple 3-wire cable (TxD, RxD, 0Volt): set CTS to 'No' and select a Baud rate which is significantly slower than the printer's printing speed. For example, if the printer prints at 40cps, select a speed of 300 Baud or less. You may need to link the printer's CTS to an active pin.

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14. Using Communications

This chapter describes how to use communications facilities, once you have set them up and connected to the other device, as described in Chapter 13.

CAUTION: Connect only approved cables and peripherals to the MP2500.

14.1 Introduction

The **MP2500** communications port can be used to connect to a very wide range of devices. These fall into two main categories: other computers and computer peripherals.

Communications provide a quick and easy way to load programs and data onto the **MP2500**, and return collected data to other systems for processing.

14.2 Selecting the communications package

As already described, the **MP2500** provides two communications packages:

- Simple IBM-compatible communications
- Sophisticated **HUSKY** (**FS3/MP2500**) communications

When you reboot, **HUSKY** (**FS3/MP2500**) communications will be selected. This provides a number of advantages over IBM-compatible communications (see section 13.2). If IBM communications has been selected but you want these advantages, select and configure **FS3/MP2500** communications by using the UTIL utility as described earlier in this manual, and simple utilities (such as COPY) and any MS-DOS applications that do not re-initialise communications will use it automatically.

If you find that an application re-initialises communications, no harm will have been done; that application will simply use IBM communications.

Applications written specifically for the **MP2500** may also select, configure and use **HUSKY** (**MP2500**) mode communications automatically.

Remember that communications on the **MP2500** is software controlled, so if **MP2500** fails to communicate, always check that the port is configured correctly.

14.3 Starting communication

When you turn the **MP2500** on, the serial interface is left turned off to conserve power. When a user program attempts to send or receive data, the **MP2500** turns its interface on automatically and waits approximately 2 seconds to allow it to settle down before beginning transmission or reception.

While the port is turning on it may send spurious characters to the remote system, which could cause problems. To avoid this you can turn the port on immediately before connecting to the remote system. For example, by typing the following in MS-DOS command mode:

COPY CON COM2 ↵
↵
Ctrl+Z ↵

The port remains turned on until you turn the **MP2500** off, so further transmissions are not affected in this way. If you are not going to use communications for a while, turn off again to save battery power. (The application may turn off the port automatically, as described in Part 3.)

14.4 Using standard facilities

The serial port can be used from standard applications, as COM2. As LPT1 is also configured as COM2, printed output will normally be routed to COM2. Redirection can be achieved through the use of UTIL and INT functions.

As supplied, communications can also be used in MS-DOS commands, by using the appropriate device name in place of a filename.

The main workhorse for MS-DOS file transfer is the COPY command. For example:

COPY COM2/A INPUT.TXT ↵

would store input received from COM2 in the file INPUT.TXT, until an end-of-file marker (Ctrl-Z) is received. Note the **/A** switch; this makes sure that Ctrl-Z is interpreted as end of file.

CAUTION: There is a problem when using the MS-DOS COPY command like this. If the transmitting system sends data slower than the receiving system requires it, the COPY command will time out, inserting a NUL (ASCII 0) character in the input for each such timeout. This is unlikely to happen if the transmitting system is simply copying data from a fast disk, but may cause problems if copying data from a slow peripheral or processing data before sending it. If this is the case, try a slower Baud rate or edit the NULs from the received file.

CAUTION: Set SERIG to ignore nulls.

`COPY LISTING.TXT COM2/A` ⏎

would transmit the file LISTING.TXT via COM2, ending with a Ctrl-Z (so the other system can detect the end of the file). Again, note the **/A** switch, which ensures that Ctrl-Z is sent. If the destination does not need to detect the end of the file (for example, is a printer), you could omit this.

These commands may be quite sufficient for transferring ASCII (text) files, but are not suitable for transferring binary files. To do this, you must use the **MP2500** HCOM utility (see section 14.5) or a communications application (see section 14.9).

COM2 is configured as LPT1 automatically, so any command that prints will usually direct its output to COM2. For example:

⇧ 🐾+P	output current screen contents to COM2 (there is no Print Screen key on the **MP2500**)
Ctrl+P	Echo subsequent screen output to COM2 until Ctrl+P pressed again
`PRINT` *filename* ⏎	queue a file for output to COM2 in background. (The PRINT command is not installed as standard.)

Standard input and output can also be redirected to the ports in the usual way. For example:

DIR >COM2 ⏎	catalogue current directory and send result to COM2
SORT <COM2 >INDEX ⏎	input text from COM2, sort it and store the result in the file INDEX. (The SORT command is not installed as standard.)

14.5 Using the HUSKY File Transfer Utility, HCOM

HCOM is a versatile file transfer utility, designed to make transferring files between a PC and the **MP2500** quick and easy. The software is in two parts: the **MP2500** part is built into the **MP2500**, while the PC part is supplied on diskette.

You control HCOM from the PC keyboard and can view directories on both the PC and the **MP2500**, and copy single files or groups of files in either direction.

HCOM is described in detail in a separate document, *The Husky File Transfer Utility Guide*, with extra information in a README file on the HCOM diskette.

14.6 Using the HUSKY XMODEM Loader, XL

XL is a file transfer utility which allows you to download a program file from a host using the XMODEM protocol and then optionally execute it on the **MP2500**. This will typically be used to update the user's application automatically.

XL is stored on the **MP2500** CompactFlash disk. To use it you will also need a third party program on the host which uses the XMODEM protocol.

14.6.1 Using XL

- Connect via the **MP2500** serial communications port (Port 1, COM2):
- Turn on the **MP2500**.
- At the DOS prompt, type the XL command:

XL [*filename*] [/R*mm*] [/P*nn*] [/ne] ⏎

Where:

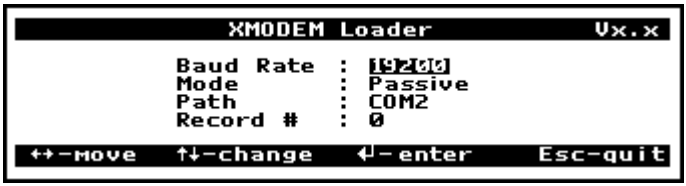
filename specifies the name to use for the received program. If omitted, **COMMS.EXE** is assumed.

/R*mm* sets the delay between reporting an XMODEM error and restarting the download to ***mm*** seconds (0..60). If omitted, 10 seconds is assumed.

/P*nn* sets the time between initial startup polls to ***nn*** seconds (0..60). If omitted, 10 seconds is assumed.

/ne specifies NOT to execute the downloaded file

- If you have specified an invalid filename, **INVALID FILENAME** will be displayed. Press Esc to return to DOS and retype the command.
- If you have specified a filename which exists already, it will be overwritten without warning.
- The display looks like this:



Note that the bottom line is also used to display status and error messages.

- This screen allows you to configure two options, by selecting an option with ← or → and then pressing ↑ or ↓ to alter it. The options are:
  - **Baud Rate**: select the Baud rate for the transfer. You should normally select the highest rate unless you experience problems.
  - **Mode**: set this to **Active** to enable transmission of the standard XMODEM protocol characters.
- The other two fields are:
  - **Path**: this will be **COM2**.
  - **Record #**: this will be blank until transfer begins.
- When the options are set correctly, press ↵ to start the transfer.
- Initially, the status line will read **POLLING**.
- When the host starts sending data, the status line will read **LOADING** and **Record #** will increment as each record is received.
- When transfer has finished, **COMPLETED - SAVING** should be displayed briefly, then the received program will be executed.

If any error messages are displayed, see section 14.6.3.

To cancel the transfer at any time, press Esc. The data which is currently being received will be discarded and you will be returned to the DOS prompt.

14.6.2 Technical information

The XMODEM protocol is a block-oriented error-checking protocol in the public domain, which uses checksums or, optionally, CRCs for error-checking. It can be used for text or binary files and is widely supported. XL uses standard XMODEM with checksums.

XL uses COM2 on startup.

When the user initiates communications (press ⏎) on the Active **MP2500**, it sends a POLL to the host, then waits for a configurable period (/Pnn parameter, default 10 seconds) before sending another POLL. If there is no response to 5 POLLs, the download will fail with an error message (see section 14.6.3).

XL uses checksums to check received blocks. If a received block is corrupted, XMODEM will request it 5 more times (by sending a NAK) before reporting an error to XL (see section 14.6.3).

14.6.3 XL error messages

The following error messages may be displayed while using the XL utility:

Communications Errors:

`Communications Timeout Error`
The connection has probably failed or has never been made. Check whether the host has hung up (modem) or cable has become disconnected (direct connection). Check that the host is on-line.

`Operator Aborted`
You have pressed Esc to cancel downloading.

`Packet Sequence Error`
A block has been received out of sequence, eg due to bad line noise. Check the line (modem) or cable (direct connection).

`Xmodem Checksum Error`
A corrupted block has been received five times. Check the line (modem) or cable (direct connection).

`Xmodem Header Error`
Check the line (modem) or cable (direct connection).

`Xmodem Startup Error`
Check the line (modem) or cable (direct connection).

After any of these errors, XL will discard any data received. An Active **MP2500** will restart the download after a configurable delay (**`/Rnn`** parameter, default 10 seconds), unless the user presses Esc first, which returns to DOS. A Passive **MP2500** will display the message until the operator presses Esc; it will not restart the download.

Other errors:

`Disk Full`
There is not sufficient disk space to store the received file. Press ↵ to return to DOS and make enough space (by deleting files) or select a different drive with enough space, then run XL again.

`Invalid Filename`
You have specified a filename in the XL command which is not a valid DOS filename. Press Esc to return to DOS and type the command again.

14.7 Using MP2500 applications

If an application has been written especially for the **MP2500**, it should handle communications automatically, selecting and configuring communications to suit the remote system, turning the port on and off as required, and trapping any errors for you.

14.8 Using MS-DOS applications

The serial port is configured as COM2 so any application that allows you to use COM2 can use communications. COM2 is also configured as LPT1, the device normally used for printer output, so printing will normally be routed to COM2.

If you are using a standard MS-DOS application, it probably won't provide any specialised communications facilities. In this case, you will probably

only be able to output data while using it, by using the application's 'printing' options. This will normally be output via COM2, as described earlier. While you could use this to print results on a suitable printer, there's nothing to stop you connecting COM2 to another computer system which requires the information.

By default, when you reboot, **MP2500** communications will be installed. To use IBM communications simply select it before running the application (eg by using UTIL).

If you need to input files, or output files in formats not supported by the application's print option, you can use the standard MS-DOS facilities described in section 14.4.

14.9 Using MS-DOS communications packages

A number of third party communications packages are available for the IBM PC and compatibles. These typically offer very high data rates via direct connections (cables), convenient menu-driven interfaces and automatic operation, including error-handling.

Some of these packages are appropriate to use with the **MP2500**, but because they are written for standard IBM PC hardware, they will not use any of the special facilities provided by **MP2500** communications. They also may not work reliably at speeds greater than 9,600 Baud. If you are at all unsure whether a package will work, ask your supplier.

14.10 File transfers

The **MP2500** uses the industry-standard RS232 interface and supports the common XON-XOFF protocol and a wide range of baud rates and data formats, so it can communicate with a wide range of computers, including microcomputer systems such as the IBM PC. Optional protocols and internal upgrades extend this range even further.

If the other system does not support 8-bit communications, to transfer binary data you must use a communications application.

14.10.1 Exchanging files with an MP2500, FS3 or FS/2

The **FS/2** comms utility COM.COM is not supplied on **MP2500** (or on **FS3**). **HUSKY** recommends that files are transferred via a PC, using HCOM (see section 14.5). Alternatively, you could load COM.COM onto the **MP2500** - contact your system provider or **HUSKY** for details.

Set up and connect the two systems as described in section 13.7.

14.11 Troubleshooting

If you are using one of the **HUSKY** file transfer utilities (HCOM or XL), refer to its documentation for a description of its error messages.

If you cannot get communications to start:

- Check that the port is configured correctly to suit the cable and host.
- Check the cable and any intervening devices (such as modems, telephone lines, opto-isolators or line buffers).
- Check that the host is ready to communicate.
- If possible, swap components (modems, cables, telephone lines) to help trace the problem.

If communications works but data is corrupted:

- Check that the **MP2500** and host are using the same data formats and speeds.
- Check that all connections are noise-free.
- Try a slower speed or more secure protocol if one is available.

If communications fails after operating correctly for a time:

- Check for noisy lines (or use a slower speed or more secure protocol).

- Check that the connection is still made (eg check that the telephone line has not been lost or a cable has not come unplugged).

- Check for component failure.

If communications fails because of timeouts, you can increase the periods or disable the timeouts entirely by using the UTIL command or by using similar options in an **MP2500** application.

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15. Accessories

This chapter briefly describes the main accessories developed by **HUSKY** for use with the **MP2500**. For more details, consult the products' user guides or approach your local distributor or **HUSKY**.

CAUTION: Connect only approved cables and peripherals to the MP2500.

15.1 Introduction

The **MP2500** uses an operating system, protocols and communications interface that are compatible as far as practicable with the main industry standards. This makes it easy for you to extend its capabilities, by adding a variety of standard peripheral devices.

HUSKY have also developed a range of their own peripherals and software enhancements for the **MP2500**, such as extra communications protocols. These are described in the remainder of this chapter.

15.2 Power

The **MP2500** can be powered by an AC adaptor, the **HUSKY** NiCd or NiMH Rechargeable Battery Sticks, or non-rechargeable alkaline batteries:

HUSKY AC adaptors:	A range is available to suit differing national requirements.
HUSKY NiCd Battery Stick:	A battery pack consisting of three A-size rechargeable nickel cadmium cells, 1.2V per cell.
HUSKY NiMH Battery Stick:	A battery pack consisting of three A-size rechargeable nickel metal hydride cells, 1.2V per cell.
Non-rechargeable batteries:	1.5V Alkaline AA size batteries, such as Panasonic or Duracell LR6 (MN1500). Three are required for operation.

HUSKY recommends the use of the rechargeable battery sticks. Alkalines are only suited to light duty applications, and are not advisable for low temperature operation.

The special **MP2500** AC adaptors are the only units which may be used to recharge the NiMH and NiCd batteries while they are installed in the **MP2500**. The use of an non **HUSKY**-approved AC adaptor or battery eliminator may damage the **MP2500** or the batteries and may contravene EMC and safety legislation.

15.3 Upgrading the BIOS and Utilities

When revised versions of the **MP2500** BIOS and utilities are released, you may be able to upgrade your existing **MP2500** units with them. Please contact your system supplier, or **HUSKY** support department.

Versions which require revised hardware may not be available in this manner. For details, contact **HUSKY** or your supplier.

15.4 Communications

The communications capabilities of the **MP2500** can be extended by adding protocols and interfaces. For details, contact your supplier.

15.5 Peripherals

15.5.1 Power for peripherals

The standard **MP2500** does NOT provide a power output (5 Volt out) via its serial connector.

16. Introduction

This part of the guide describes how to select, install, adapt or write applications for **MP2500**. It also provides background information which may be of interest if you wish to use non-standard peripherals.

16.1 Using this part of the guide

The information provided in this part of the *MP2500 System Developer's Guide* is of four main types:

Chapters 16 to 18	General guidelines on installing, adapting and developing applications for **MP2500**, including a system overview, compatibility issues, programming tools, etc.
Chapters 19 to 30	Summary technical information, describing the **MP2500** BIOS and software interrupts, with particular emphasis on those aspects that are not industry-standard (ie extensions and restrictions). This information is mainly intended for readers with extensive experience of programming in an IBM PC-DOS or MS-DOS environment.
Chapters 31 to 32	A description of the **MP2500** memory map and hardware, with particular emphasis on the power management and handling system.

16.2 Assumptions

This part of the guide is not a tutorial in computer programming or hardware. Nor is it intended to describe standard MS-DOS and the IBM PC hardware environment.

This part of the guide also assumes that your are familiar with the contents of Parts 1 and 2.

You are assumed to have a working knowledge of:

- 80386 assembler, or how to call interrupts from your high-level language
- Standard MS-DOS interrupts
- Standard IBM PC BIOS interrupts
- IBM PC hardware environment

If you don't, you will need to refer to the MS-DOS Programmer's Manual and other standard texts on IBM compatibles and 80386 assembler.

16.3 Conventions

The same conventions are used in this part of the guide as in previous parts, but they are supplemented in places by the following:

[–] This is an IBM PC-AT facility (interrupt, device, register, etc) which is **not** implemented on **MP2500**.

[+] This is an extra **MP2500** facility (interrupt, device, register, etc), ie one not implemented on the IBM PC-AT.

17. Installing Standard Applications

This chapter describes how to select and install third party applications, such as database or PIM packages, etc. Subsequent chapters describe how to install or modify applications which you have developed yourself, or for which you have source code.

17.1 Compatibility

MP2500's industry-standard operating system means that well-behaved MS-DOS or IBM PC applications can be used, provided that they can use the hardware configuration, namely:

Display adaptor type:	CGA. Note that the screen is only two-colour, so applications that make extensive use of colour may cause problems.
Memory:	The memory available depends on the use of TSR programs and device drivers. Use the MS-DOS MEM command to check for free memory. Check that the application can run within the free DOS memory. If you have any TSR programs installed (including PRINT or MODE), consider removing them or loading them high. (The **MP2500** supports the use of the HMA space via HIMEM.SYS to allow DOS to be loaded high).
Disk:	A standard unit is configured with a single disk drive, the CompactFlash disk, as drive C. This behaves like a hard disk Check that the application and its data files can fit in the available disk space.
Printer:	The **MP2500** is fitted with a single serial port as standard. Printing is via this serial port..

Certain applications include copy-protection that relies on a specially formatted diskette, or special device (dongle) connected to a parallel printer

port. These will not work on **MP2500**. Such applications are rare, and you may be able to obtain an unprotected version on special request.

The **MP2500** hardware is to a large extent IBM PC-compatible, so you can even use many 'badly behaved' applications too, such as most TSR packages.

Note: If you are in any doubt about the suitability of a particular package, contact your supplier or **HUSKY**, or arrange to test the application (see section 17.4).

17.1.1 Problems with interrupts

NMIs: On IBM PCs, NMIs are either used to report a RAM parity error or not used at all. The **MP2500** uses NMIs for several other purposes. While this is generally not a problem, it can affect the use of certain packages, described here.

If an application redirects the NMI vector, this will crash or hang the **MP2500**. Programs that do this include CODEVIEW, TURBO BASIC (or POWER BASIC) and some C++ compilers. To use such a program, you must patch the code to either prevent redirection or cascade the application's NMI handler from the **MP2500** one. An application's NMI handler is normally used as a "catch all" error handler, eg to catch numeric co-processor errors, on a PC-AT system. Contact your system supplier or **HUSKY** if you experience difficulties.

Maskable interrupts: Finally, applications which rely on the use of the CLI instruction to mask (disable) all interrupts other than NMI may also cause problems, since NMIs are issued regularly on the **MP2500**, unlike the PC (where it indicates a memory error and halts the system).

17.1.2 Other compatibility issues

MP2500 is more PC-compatible than some earlier **HUSKY** computers such as the **HUSKY FS/2**. For example, it uses a PC-compatible 16450 UART, Timer, Interrupt Controller and HDC devices; the processor does not have any reserved flags; the disk architecture is entirely PC-compatible and the BIOS entry points are also standard.

However, there are a few minor areas of limited compatibility that might still affect you:

Compatibility issue	Comments
Periodic NMIs	NMIs occur periodically including times when Application software has attempted to disable all interrupts. The NMIs can reduce comms throughput slightly at very high rates.
6845 video controller is emulated	The only effect you may notice is a slight reduction in speed.
8042 keyboard interface is emulated	This is of limited significance since this interface is only used by the keyboard handler.
Reserved memory locations	Memory from 0B800:4000 to 0B800:7FFF must not be written to.
Split cursor not supported	**HUSKY** are not aware of any applications that use this feature.
"Invisible" character attribute (00H) not supported	**HUSKY** are not aware of any applications that use this feature.
Non-standard keyboard layout	The keyboard is configurable and provided with its own utility for configuring the keyboard for different countries (I.EXE - see Part 2). Do not use the MSDOS standard utility KEYB.

Note: Any program written for the **FS/2** or **FS3** should already handle these.

17.2 Porting the application

To use an application, you must load it onto a desktop computer, then use communications to load it onto the **MP2500** disk. See Part 2 for details of loading files with communications.

To make the best use of disk space, only install those files that are really required for operation. For example, don't install tutorial files or drivers for printers that are not going to be used.

17.3 Configuring

Once you have copied the software onto **MP2500** you may have to configure it to suit. Some applications do not need configuring, while others configure themselves automatically.

Refer to the application's installation guide for instructions.

The following brief details may assist you in this. If you need more details, see the full specification in Appendix A.

Display adaptor type:	CGA monochrome. If possible, install using a monochrome option.
Operating system:	MS-DOS 6.22.
Memory:	The memory available depends on the version of **MP2500**, the fitting of memory expansion options and use of TSR programs and device drivers. Use the MS-DOS CHKDSK utility to check. DOS extenders and expanded memory (EMS) using EMM386.EXE are not supported.
Processor:	Intel i386EX. 8MHz clock speed standard.
Keyboard:	Generally compatible with the IBM PC standard keyboard, but with a different layout and omitting some keys.

Disks: The standard **MP2500** disk drive is the CompactFlash drive, configured as drive C, which behaves like a hard disk.

Printer: The standard **MP2500** is fitted with a single serial port (COM2), with the system configured to automatically redirect printing to LPT1 to COM2.

Serial ports: One (COM2) on **MP2500** as standard.

As part of the configuration process, you may have to make changes to CONFIG.SYS and AUTOEXEC.BAT. You may find the ED utility useful for this. Note that if you change the PATH, you should include C:/ on it if you want to continue to provide easy access to COMMAND.COM, UTIL and ED (the text editor).

MP2500 provides a slightly unusual environment, so note the following when setting up these files:

CONFIG.SYS Using the internal disk (drive C), there is no need for a BUFFERS command, since this disk is very fast. This will leave more main memory for your applications.

Standard DOS device drivers (such as ANSI.SYS) are in the C:\DOS directory.

AUTOEXEC.BAT Remember that this file is only executed when **MP2500** is booted.

A desktop computer boots each time it is turned on or Ctrl-Alt-Del is pressed, but **MP2500** will normally only reboot if you use emergency breakout or the hardware reset sequence (see Part 2) which ordinary users should not know about (an application will usually disable Ctrl-Alt-Del reboot).

Turning off and on will therefore normally restore the same environment eg leaves the current application running, restores the display, environment variables, current directory, etc. (You

can change this from within custom applications by using INT 15H, as described later.)

This is generally very helpful, but does mean that you should not rely on AUTOEXEC.BAT to run an application each time **MP2500** is turned on.

17.4 Testing

Once you have installed and configured the application, you should run it and use its main functions briefly, to make sure that operation is correct. In particular, check that:

1 Screen behaviour is acceptable. For example, is text highlighting invisible, or is the LCD screen constantly scrolling to show output in two different areas of the virtual screen? (If there is a problem, see section 17.5.2.)

2 When the user leaves the application or selects a DOS command, it is executed correctly. (If not, check COMSPEC and PATH.)

3 Any utilities that the user or application might need have been installed. (If not, install them.)

4 Printing works correctly, if appropriate. If not, you may need other device drivers (see the application installation instructions) or need to configure communications (see Part 2).

17.5 Special considerations

17.5.1 Batteries

MP2500 will usually be operated from batteries while in the field. Its sophisticated power monitoring system will help get the maximum trouble-free operating time from a set of batteries.

MP2500 has one power management mode, which is based on the Standard Power Management (SPM) mode of the **HUSKY FS3**. Battery levels are continuously monitored for the low battery condition. Charging can be enabled/disabled via UTIL or by the application.

The **MP2500** is normally shipped without the batteries fitted when it leaves the factory.

Whichever battery type is fitted, if battery power gets very low, **MP2500** will shut down automatically, to avoid losing RAM and clock contents.

If **MP2500** is fitted with rechargeable batteries, you need to select the battery type using the non-volatile configuration option of UTIL and enable the battery charging support. Batteries will typically be recharged overnight. If you want users to be able to charge the batteries, you must warn them not to attempt to recharge Alkaline batteries.

It is recommended that you read the *MP2500 User Leaflet*, which describes the initial setting up of an **MP2500**.

If **MP2500** is fitted with Alkaline batteries, you may prefer to disable battery charging support, provide users with a spare set of batteries, and tell them how to change batteries.

Due to the potential risks of attempting to recharge Alkaline batteries, you should only provide responsible personnel with an AC adaptor (see section 8.2.4).

For details of charging and changing batteries, and using the AC adaptor, see section 8.2.

17.5.2 Display

As far as practical, the display emulates an IBM CGA screen, but it can only display two colours (black and white) and is not large enough to display the whole screen at one time (it normally moves across a virtual whole screen, to show the latest output).

The emulation will be entirely satisfactory for most uses, but may cause problems when running some standard application.

To help solve such problems, you can use the HOT key, as described in Chapter 11. For example, if highlighting does not work correctly, you can use the HOT key to display selected screen attributes as inverse video. If you need to display two separate parts of the CGA, you can use the HOT key to split the display into two separate windows, and use a different part of the LCD for each.

For details of using the HOT key, see Chapter 11. Note that users will not normally have access to the HOT key, so you must set up the display for them.

17.5.3 Training

If a user is running a standard application on **MP2500**, their main source of information must be the application's own guides. However, these may have been written for use on a desktop computer, so users should be made aware of the differences that using **MP2500** will make.

The main points to indicate are:

1 The procedure for battery charging/replacement. (See section 17.5.1.)

2 The modified keyboard key sequences required for certain keystrokes.

3 Controlling the display.

Most of these points are covered in the *MP2500 User Leaflet*, but you may need to supplement this information with the more detailed descriptions in Part 2.

18. Adapting Applications

This chapter describes briefly how to adapt applications for which you have the source code so that they will run on **MP2500**. See Chapter 17 for general background on the operating system, utilities, and special considerations. That chapter also describes how to install standard applications.

18.1 Using PC-DOS or MS-DOS software

If you have the source code for a program that was written for MS-DOS, you should be able to compile and run it on **MP2500** without any changes, provided that it meets the criteria described in section 17.1.

For programs that are "well-behaved" ie use the documented BIOS and MS-DOS interrupts for access to the hardware; the minor differences between the **MP2500** hardware and IBM PC hardware should not matter. The **MP2500** MS-DOS interrupts are standard, while the changes to the BIOS are mainly IBM-compatible extensions.

If a program was written specifically for IBM PC or PC-AT hardware, it is more likely to be 'badly behaved' ie to access the hardware directly. The **MP2500** emulation of the IBM PC-AT hardware is very good, but not perfect, so there is a risk that such access will not succeed. For details of the differences, refer to the hardware chapter, Chapter 31.

Note that **MP2500** limitations are indicated by [-], while enhancements are indicated by [+].

Even if the program will compile and run as it is, you may prefer to modify it to take advantage of some of the extra facilities provided by **MP2500**, such as power management and graphics primitives. These facilities are described in subsequent chapters.

Of particular interest are facilities such as inverse video mapping and keyboard redefinition, which allow you to 'fine-tune' facilities and minimise the need for re-designing standard applications.

18.2 Using FS/2 or FS3 software

A program that was especially written for the **HUSKY FS/2** or **FS3** should run with little or no changes on the **MP2500**, unless it relies on any of the facilities which have been deleted within the **MP2500**, or relies on software timing loops (the **MP2500** is considerably slower than the **FS3**, but about the same speed as the **FS/2**).

Note that the **MP2500** has a single communications port - serial port, COM2 only.

If the program calls a function which is not provided by the **MP2500** BIOS, the call will return with the carry flag set to indicate failure.

For a more detailed description of the differences between the **FS/2**, **FS3** and the **MP2500** from a programmer's point of view, see Appendix G.

19. The Interrupts

This chapter briefly describes the interrupts used on **MP2500**. The BIOS interrupts are described in detail in Chapters 20 to 30. The hardware interrupts are described in section 31.3. The MS-DOS interrupts are described in the MS-DOS Programmer's Manual.

19.1 Summary

The Intel i386ex microprocessor supports 256 different interrupts. There are three types:

- **BIOS interrupts**, instructions executed by programs, as an economical way of calling routines in the BIOS (such as the video display or communications services).

- **Hardware interrupts**, issued by a device manipulating control lines, as a way of requesting service from the BIOS (such as responding to a timer tick or key depression).

- **Microprocessor interrupts**, issued by the microprocessor itself under certain circumstances (such as an attempt to divide by 0 or arithmetic overflow).

All interrupts are vectored from low RAM, to allow an application to service the interrupt with its own routine. The routine can be used to change the normal response to an interrupt, or to provide a response where one is not normally made (as indicated by IRET in the following table). The vectors are restored to their defaults by a cold start (power up in non-resume mode, or after emergency breakout or loss of all power).

The main vector addresses and default contents on **MP2500** are summarised in the following table. To change a vector, you can write direct to memory or use the DOS 'set interrupt vector' function (see the *MS-DOS Programmer's Manual*).

CAUTION: **You must not change the vector for INT 2 (which services NMIs), as NMIs are vital to operation of MP2500. If you change this vector, MP2500 will stop operating.**

Address	INT	Description	Default vector
00..03H	00H	Divide by 0	IRET
04..07H	01H	Single step	IRET
08..0BH	02H	NMI	NMI routine. **Do not alter!**
0C..0FH	03H	Breakpoint	IRET
10..13H	04H	Arithmetic overflow	IRET
14..17H	05H	Print screen	BIOS print screen
18..1BH	06H	RESERVED	IRET
1C..1FH	07H	FPO instruction	IRET
20..23H	08H	H/W. Time of day	BIOS timer tick routine
24..27H	09H	H/W. Keyboard	Key store routine
28..2BH	0AH	RESERVED	IRET
2C..2FH	0BH	H/W. COM2 port	IRET
30..33H	0CH	H/W. COM1 port	IRET
34..37H	0DH	H/W. Fixed disk	IRET
38..3BH	0EH	H/W. Diskette	IRET
3C..3FH	0FH	H/W. Printer	IRET
40..43H	10H	Screen control	BIOS video routine
44..47H	11H	Equipment check	BIOS equip check routine
48..4BH	12H	System memory	BIOS memory size routine
4C..4FH	13H	Disk control	BIOS disk control routine
50..53H	14H	Communications	BIOS comms routine
54..57H	15H	Cassette control	BIOS extension routine
58..5BH	16H	Keyboard control	BIOS keyb'd control routine
5C..5FH	17H	Printer	BIOS printer routine
60..63H	18H	Not implemented	IRET
64..67H	19H	Bootstrap	BIOS disk bootstrap
68..6BH	1AH	Time of day	BIOS clock/RTC routine
6C..6FH	1BH	Ctrl-Break	IRET
70..73H	1CH	Timer 'tick'	IRET
74..77H	1DH	Video parameters	BIOS video parameters
78..7BH	1EH	Diskette parameters	BIOS diskette parameters
7C..7FH	1FH	Graphics characters	Default upper 128 graphics characters
80..9CH	20H ..27H	MS-DOS services	See the *MS-DOS Programmer's Manual*
1C0..1C3H	70H	Comms timeout	IRET
1C4..1C7H	71H	Reserved	
1C8..1CBH	72H	Power on/off notify	IRET

19.2 BIOS interrupts

BIOS interrupts provide convenient access to low-level facilities. The following table summarises the BIOS interrupts provided on **MP2500**. Subsequent chapters describe each one in more detail.

The **MP2500** BIOS interrupts are compatible with the IBM PC-AT BIOS, except where the following symbols appear:

[+] means this interrupt provides facilities in addition to those of the equivalent PC BIOS interrupt. Using these will make better use of **MP2500**'s potential, but may reduce portability of your programs.

[-] means this interrupt does not provide all the facilities of the equivalent PC BIOS interrupt. If you wish to use this interrupt, take careful note of the description of the differences.

If an interrupt has neither of these symbols against it in the following table, you may safely assume that it behaves as in the IBM PC-AT BIOS.

INT	Standard function	Differences
05H	Print screen	[+]
10H	Screen control	[+][-]
11H	Determine system equipment	
12H	Determine system memory	
13H	Disk control	
14H	Serial port control	[+][-]
15H	BIOS extension function	[+]
16H	Keyboard control	[+]
17H	Printer control	
18H	Activate ROM BASIC/end program	Not implemented
19H	Boot DOS	
1AH	Timer/clock control	[+]

The BIOS interrupts are described in numerical order in the following chapters.

Many of the extra BIOS interrupts are used to change **MP2500**'s behaviour, by altering default settings such as the battery type or keyboard layout. These changes are in general preserved until the next **cold start**. A cold start is produced by a power-up in non-resume mode, or after emergency breakout or loss of all power.

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20. INT 05H, Print Screen Contents

Use

Dumps the contents of the virtual screen to serial port COM2, as ASCII characters ie 'prints' the screen.

Entry

No parameters are passed.

Exit

All registers and flags are preserved.

The status byte at 50:0 in the MS-DOS data segment is set to indicate the result of the operation:

00H - printing is idle or has completed successfully
01H - printing is active. Any further print requests will be ignored
FFH - the previous print operation failed

Comments

This function is normally used by pressing **PrtSc** or **Shift**+**PrtSc** on PC-compatibles.

The main differences on **MP2500** are:

1 The function can be invoked with the default (developer) keyboard by pressing ⓕP, or ⇧ⓕP in the user mode.

2 The function will print the whole of the virtual screen (not the LCD window).

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21. INT 10H, Screen Handler

Use

Screen control output.

Entry

AH selects the function required, while other registers are used for parameters, as follows. Cursor co-ordinates are range-checked and 'clipped' to keep them within the allowed range (row: 0-24; column: 0-79).

Exit

On exit, AX is corrupted. Other exit conditions are as described for the individual function.

Comments

PC BIOS provides the following functions:

00H	Set screen mode
01H	Set cursor size
02H	Move cursor
03H	Get cursor position
04H	Get lightpen address
05H	Set display page
06H	Scroll up
07H	Scroll down
08H	Read character and attributes
09H	Write character and attributes
0AH	Write character
0BH	Set colour palette
0CH	Write pixel
0DH	Read pixel
0EH	Write character as TTY
0FH	Get video state
10H	EGA/VGA colour palette
11H	EGA/VGA character generator
12H	EGA/VGA alternate select
13H	Write character string

The **MP2500** BIOS provides identical functions, with the following exceptions:

- 04H: replaced by a 'get cursor address' function, as the display hardware does not support a lightpen.
- 0BH: not implemented.
- 10H, 11H and 12H: not implemented.
- 13H: only subfunction 00H.

While these functions are highly compatible, remember that the display hardware is only capable of displaying two colours (black and white) and the inverse video attribute. So, while you can use the 'colours' and attributes that each screen mode supports, the visible result is constrained by the hardware.

For example: If a pixel were written with the colour red, it would be displayed as black, but its colour would be read (direct from screen memory or via the appropriate function) as red.

MP2500 also provides a number of extended functions to provide easy access to its special features:

60H Set graphics font
61H Move cursor to graphics co-ordinates
62H Get cursor position in graphics co-ordinates
63H Set contrast
64H Reserved
65H Get/set backlight timeout
66H Split display
70H Draw ellipse/circle
71H Draw line/box
72H Select inverse video mechanism
73H Set text font
74H Set LCD window position
75H Reserved
76H Looking keys
77H Get graphics font
78H Turn backlight on/off
79H Reset screen parameters
7AH Get contrast and backlight states
7BH Set bold attribute mask

The IBM extended character set (ASCII codes 128-255) is supported in all three graphics modes as well as text modes.

Set screen mode

Entry AH=00H
AL=mode

Description Selects the screen mode, clearing the screen if it is changed. The modes are as follows:

Mode	Description
0	text, 25 x 40, mono
1	text, 25 x 40, colour
2	text, 25 x 80, mono
3	text, 25 x 80, colour
4	graphics, 320 x 200, palette 0
5	graphics, 320 x 200, palette 1
6	graphics, 640 x 200, mono

[-] In text modes, **MP2500** can display text attributes (including colours) as inverse video: see the description of function 72H.

In the colour graphics modes, **MP2500** displays all 'colours' as black or white, as follows:

Colour	Displayed as
0	black
1	white
2	black
3	white

Set cursor size

Entry AH=01H
CH=start scan address (00..1FH)
CL=end scan address (00..1FH)

Exit Returns nothing

Description Changes the cursor size. To make the cursor invisible, set CH to 1FH or set bit 6.

Move cursor

Entry AH=02H
BH=page
DH=row
DL=column

Exit Returns nothing

Description Moves the cursor to the specified row and column of the specified display page.

A second page is only supported in modes 0..3.

Get cursor position

Entry AH=03H
BH=page

Exit CH=start scan address
CL=end scan address
DH=row DL=column

Description Reads the cursor position.

A second page is only supported in modes 0..3.

Get cursor address [+][-]

Entry AH=04H
BH=page

Exit DH=row (0..24)
DL=column (0..79)
BX=cursor pixel column (0..639)
CX=cursor pixel row (0..199) (pixel co-ordinates are for bottom left corner of character cell)

Description Reads the current cursor position, in text and graphics co-ordinates

[+][-] This function returns the lightpen address, in the IBM BIOS, but **MP2500** does not support connection of a lightpen.

Set display page

Entry AH=05H
AL=page

Exit Returns nothing

Description Selects the display page, in text modes (0..3).

Scroll up

Entry AH=06H
AL=number of lines to scroll
BH=filler attribute
CH=top row
CL=left column
DH=bottom row
DL=right column

Exit Returns nothing

Description Scrolls the area defined by CH, CL, DH and DL, moving it up by the number of lines given by AL, filling the 'blank' lines with the filler character given by BH.

If AL=00H, the area is cleared.

[+] This function works in all screen modes. The IBM BIOS function only works in text modes.

Scroll down

Entry AH=07H
AL=number of lines to scroll
BH=filler
CH=top row
CL=left column
DH=bottom row
DL=right column

Exit Returns nothing

Description As 'scroll area up', but scrolls down!

[+] This function works in all screen modes. The IBM BIOS function only works in text modes.

Read character and attributes

Entry AH=08H
BH=page

Exit AH=attribute
AL=character

Description Reads the character at the cursor. The ASCII code is returned in AL, the attribute bits in AH. (Attribute bits are only significant in text mode.)

[+] If you have been using the graphics font facilities (see function 60H), the result will only be meaningful if all characters on the screen are the same size as the current font.

Write character plus attributes

Entry AH=09H
AL=character
BH=page
BL=attribute/colour
CX=repeats

Exit Returns nothing

Description Writes the character specified by AL at the cursor, CX times. The cursor does not move.

In text modes, BL specifies the text attributes. For the 8x6, 12x8 and 12x16 fonts, selected text attributes will be displayed as a bold font. The default is to display the background and foreground intensity bits as bold, but see function 7BH.

In graphics modes, if bit 7 is 0, bits 0 and 1 specify the foreground colour; if bit 7 is 1, the colour specified by bits 0 and 1 is XORed with the current pixel colours.

Write character

Entry AH=0AH
AL=character
BH=page
CX=repeats

Exit Returns nothing

Description As 'write character plus attributes' (function 09H), but the character is written with the current attribute of the cursor position.

Write pixel

Entry AH=0CH
AL=colour/mode
CX=column
DX=row

Exit Returns nothing

Description Writes a single pixel, in graphics modes.

AL dictates the pixel colour as follows. If bit 7 is 0, bits 0 and 1 specify the foreground colour; if bit 7 is 1, the colour specified by bits 0 and 1 is XORed with the current pixel colour.

Read pixel

Entry AH=0DH
CX=column
DX=row

Exit AL=pixel colour

Description Reads the colour of the specified pixel, in graphics modes.

Remember that **MP2500** can only display two colours (black and white), but supports the full range of pixel colours. For example, if a pixel were written with the colour blue, it would be displayed as black, but its colour would be read back as blue.

Write character as TTY

Entry AH=0EH
AL=character
BL=colour (graphics mode only)
BH=page

Exit Returns nothing

Description Writes the character specified by AL, with the colour specified by BL, advancing the cursor afterwards.

Get video state

Entry AH=0FH

Exit AL=mode
AH=width (columns)
BH=page

Description Returns information about the current screen set-up.

Write string [-]

Entry AH=13H
AL=0
BL=attribute
BH=page
DX=starting cursor position
CX=length
ES:BP=address of start of string

Exit Returns nothing

Description Writes a string to the specified position, without moving the cursor. (If you are using a font other than 0, the cursor positioning information is ignored ie the text is output at the current cursor position.)

[+] This function is not provided by the IBM PC BIOS, but is provided by the IBM PC-AT BIOS.

Set graphics font [+]

Entry AH=60H
AL=size (0..6 and 128..135)

Exit BH=cell width
BL=cell height

Description Selects the font (character size) to use for subsequent screen output, in mode 6. If the top bit of AL is set, the characters are output in reverse video. This does not clear the screen, so you can use it to mix different fonts on the screen.

The sizes are as follows:

Font no.	Character (Y x X)	Cell (Y x X)	Co-ordinates (rows x columns)
0 or 128	7 x 7	8 x 8	25 x 80 [40]
1 or 129	7 x 5	8 x 6	25 x 106 [53]
2 or 130	9 x 7	10 x 8	20 x 80 [40]
3 or 131	9 x 14	10 x 16	20 x 40 [20]
4 or 132	18 x 7	20 x 8	10 x 80 [40]
5 or 133	18 x 14	20 x 16	10 x 40 [20]
6 or 134	5 x 3	6 x 4	25 x 160 [80]
7 or 135	7x5	8 x 6	25 x 106 [53]

(Figures in square brackets are for the medium resolution modes.)

The character spacing (cell size) and cursor size adjust to the new font automatically. When you change font, the cursor is left positioned immediately to the right of the last character output, with the same top line, so you should normally position the cursor before you output text in the new font.

This function is ignored in text modes. A related facility is however provided by function 73H.

Font 7 is a bold version of font 1. For more details of these fonts, see Appendix C.

Move cursor to graphics co-ordinates [+]

Entry AH=61H
CX=col
DX=row

Exit Returns nothing

Description Moves the cursor to the specified graphics co-ordinates, in a graphics mode. The position specified is actually the top left corner of the current character cell.

This function is ignored in text modes.

Get cursor position in graphics co-ordinates [+]

Entry AH=62H

Exit CX=col
DX=row

Description Reads the cursor position in graphics co-ordinates, in a graphics mode. The position returned is actually the top left corner of the current character cell.

This function is ignored in text modes.

Set contrast [+]

Entry AH=63H
AL=contrast (0..127)

Exit Returns nothing

Description Sets the LCD screen contrast to improve visibility. The contrast can also be altered by using the contrast keys: ⇧ (SHIFT) plus ↑ or ↓.

Get/set backlight (option) timeout [+]

Entry AH=65H
AL=0 (get) or 1 (set)
BX=time (0..012CH) if set

Exit BX=time (0..012CH) if get

Description Gets or sets the time after which the optional backlight will turn off automatically, if no keys are pressed. The time is specified in seconds, with a maximum of 012CH (5 minutes). 0 specifies no timeout.

Split display [+]

Entry

AH=66H
AL=control bits
BH=top row of lower section of LCD (0..7)
BL=top row of lower section of virtual screen (0..24)

Exit

Returns nothing

Description

Splits the LCD screen horizontally into two parts and assigns each to a separate part of the virtual screen. Each part may be scrollable or fixed.

The control bits are as follows:

D0, D1: if 01, no split. If 10, split.

D2: if 0, no scrolling of top part. If 1, allow scrolling

D3: if 0, no scrolling of bottom part. If 1, allow scrolling

If scrolling is allowed, that part of the LCD will scroll to display output in that part of the virtual screen.

If scrolling is not allowed, that part of the LCD will remain fixed in the current part of the virtual screen (although you can change the view by moving the cursor into the window and using function 74H).

This facility can also be controlled by using the HOT key (🐾H in the default (developer) keyboard mode, ⇧🐾H in user keyboard mode).

Draw ellipse/circle [+]

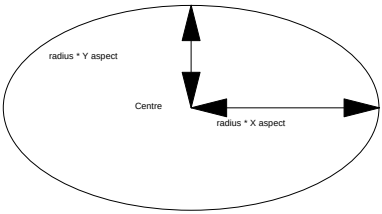
Entry

AH=70H
DS=data segment of data buffer
BX=offset into segment

Exit

Returns nothing

Description Draws an ellipse or circle in graphics modes. The graphic is drawn according to the data in the buffer, which is as follows:



Byte1: centre X co-ordinate LSB
Byte2: centre X co-ordinate MSB
Byte3: centre Y co-ordinate
Byte4: radius LSB
Byte5: radius MSB
Byte6: colour (0=white, 1=black, 0FFH=invert)
Byte7: aspect ratio x:x factor (1..127)
Byte8: aspect ratio y:y factor (1..127)

The graphics co-ordinates depend on the screen mode, as described for function 0. If any values are out of range, the function is ignored.

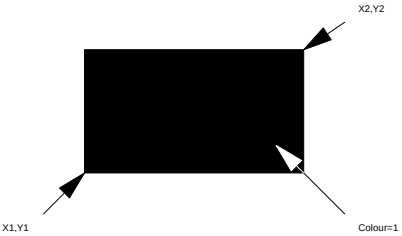
This function is ignored in text modes.

Draw line/box [+]

Entry AH=71H DS=data segment of data buffer BX=offset into segment

Exit Returns nothing

Description Draws a line, box or filled box from x1,y1 to x2,y2 in graphics modes. The graphic is drawn according to the data in the buffer, which is as follows:



Byte1: x1 X co-ordinate LSB
Byte2: x1 X co-ordinate MSB
Byte3: y1 Y co-ordinate
Byte4: x2 X co-ordinate LSB
Byte5: x2 X co-ordinate MSB
Byte6: y2 Y co-ordinate
Byte7: colour (0=white, 1=black, 0FFH=invert)
Byte8: type: 0=line, 1=box
Byte9: fill: 0=none, non-0=fill with colour

(fill is only valid if type is box)

The graphics co-ordinates depend on the screen mode, as described for function 0. If any values are out of range the function is ignored.

This function is ignored in text modes.

Select inverse video mechanism [+]

Entry AH=72H
AL=mechanism

Exit Returns nothing

Description Permits use of inverse video to emulate various text screen attributes, according to the value of AL:

AL	Effect
0	Do not use inverse video.

1 Emulate MDA ie display attribute byte 07H as normal video (white on black background) and 70H as inverse video (black on white background).

2 Use inverse video if background colour other than black.

3 Use inverse video for high intensity text.

4 Use inverse video for text with background intensity greater than foreground intensity.

5 Use inverse video for text with background colour other than black or high intensity foreground.

Note that use of this mechanism is entirely transparent to applications: it has no effect on screen memory or functions that read or write text.

In graphics modes, there are no text attributes, so this has no effect.

Select text font [+]

Entry AH=73H
AL=size (0,1,6,7,8,9, A)

Exit BH=cell width
BL=cell height

Description Selects the font (character size) for the entire screen, in a text mode. This displays the whole screen using the new font, allowing you to view more text at one time, at the expense of legibility.

Whatever the font, the entire screen remains 25 lines of 80 columns. The character spacing (cell size) and cursor size are adjusted to the new font automatically.

The sizes are as follows:

Font no.	Character (Y x X)	Cell (Y x X)
0	7 x 7	8 x 8
1	7 x 5	8 x 6
6	5 x 3	6 x 4
7	10 x 7	12 x 8
8	10 x 14	12 x 16
9	7 x 10	8 x 11
A	7 x 10	16 x 16

Font 1 is the default font, selected when you change screen mode.

Selecting font 0 or 1 has no effect on the screen memory, so it is entirely transparent to applications. In effect, it simply magnifies or reduces the view provided by the LCD screen, so that more or less text is visible at a time.

This function is ignored in graphics modes. A related facility is however provided by function 60H.

Text size can also be changed by using the HOT key (🐾H in the default (developer) keyboard mode, ⇧🐾H in user keyboard mode).

For more details of these fonts, see Appendix C.

Set LCD window position [+]

Entry AH=74H
DH=row
DL=column

Exit Returns nothing

Description Moves the LCD screen over the virtual screen to position its top left corner at the specified row and column, with row 0, column 0 being the top left corner of the virtual screen and row 25, column 80 being the bottom right corner.

(These row and column co-ordinates are unaffected by changing the text font (size); they are always based on the default 7x7 character matrix.)

Note that this has no effect on the screen memory, so it is entirely transparent to applications.

If the LCD is split (function 66H), this function moves that part of the LCD which is displaying the cursor; the other part of the LCD is unaffected.

Looking keys [+]

Entry AH=76H
AL=action

Exit Returns nothing

Description Moves the LCD across the virtual screen as if the user had pressed one of the looking keys. The action is dictated by AL, as follows:

AL	Effect
0	home the window
1	move up 1
2	move down 1
3	move left 1
4	move right 1
5	flip window to other side of virtual screen

Get graphics font [+]

Entry AH=77H

Exit AL=font number

Description Returns the currently selected graphics font number in AL. See the description of function 60H for details of font numbers.

Turn backlight (option) on/off [+]

Entry AH=78H
AL=control 0=turn off, non 0=turn on

Exit Returns nothing

Description Turns the LCD's optional backlight on or off. Remember that use of the backlight decreases the battery life considerably.

The backlight can also be toggled on and off by using ⌘L (in developer keyboard mode) or ☼ (in user keyboard mode).

Reset screen parameters [+]

Entry AH=79H

Exit CF=0

Description Resets the screen parameters to the following defaults:

Full block cursor
Video mode 2
Reset split screen parameters
Allow LCD cursor synchronisation
Allow power control in hot key
Allow hot key
Set contrast level to default
Switch backlight (option) off
Set backlight (option) timeout to 2 minutes
Set upper 128 graphics character definitions to BIOS defaults

Get contrast and backlight (option) state [+]

Entry AH=7AH

Exit BH=contrast level (1..80H)
BL=backlight level (0=off, 1=on)

Description Reads the current contrast and backlight (option) states.

Set bold attribute mask [+]

Entry AH=7BH

Exit AL=attribute mask

Description Sets the mask which dictates which text attributes will be displayed as bold, for the 8x6, 12x8 and 12x16 text fonts. Setting a bit to 1 means that if the corresponding character attribute bit is set to 1, the bold font will be used for that character.

Note: The bold attribute mask is reset to 00H by using INT 15H function 98H (redefine soft font), so that bold is not used.

The default attribute mask is 88H, so that characters with the background or foreground intensity bits set will be displayed as bold.

Bit (ATn)	Definition
7	Intensity (Background) or Enable Blink (Depends on Mode Control Bit 5)
6	Red (Background)
5	Green (Background)
4	Blue (Background)

3	Intensity (Foreground)
2	Red (Foreground)
1	Green (Foreground)
0	Blue (Foreground)

22. INT 11H, Check System Equipment

Use

Determines the standard equipment fitted.

Entry

No parameters are passed.

Exit

AX is bit-significant, indicating the equipment fitted. A standard **MP2500** will return the following:

Bit	Significance	Value on MP2500
0	Diskette drives	1 (present)
1	Maths co-processor	0 (absent)
2,3	Base RAM size	00 (unused)
4,5	Initial video mode	01 (80x25 CGA)
6,7	Diskette drives minus 1	10 (two drives)
8	DMA installed	0 (absent)
9,10,11	Serial ports	001 (one)
12	Game I/O	0 (none)
13	Not used	0
14,15	Printer ports 01	10(one)

Comments

This function behaves exactly as it does under the PC BIOS.

The equipment list is compiled when MS-DOS is booted.

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23. INT 12H, Check Memory Size

Use

Reads the amount of main memory.

Entry

No parameters are passed.

Exit

AX=main (DOS) memory size, in KByte. This will be in multiples of 32.

Comments

This function behaves exactly as it does under PC BIOS.

(This page intentionally left blank.)

24. INT 13H, Disk Handler

Use

Disk drive control and I/O. **MP2500** supports two ATA drives and as standard is supplied fitted with one, an internal CompactFlash device configured as drive C.

MP2500 also supports a diskette drive - a **HUSKY** Oracle GT disk drive connected to COM2, accessed as drive B. A PC's drive A can also be accessed by using comms and the ORACLE or INTERLINK utility, as described in Part 2 (see Chapter 10, *Utilities*). (Note that the **HUSKY** Oracle GT disk drive is no longer available.)

Entry

AH selects the function required, while other registers are used for parameters, as follows.

Exit

On exit from an operation, if it was successful, CF=0 and AH=00H. If it was unsuccessful, CF=1 and AH indicates the status, as follows:

AH	Status
0	Operation successful
1	Bad command or drive
2	No address mark
3	Write failed to write-protected disk
4	Sector not found
7	Bad parameter table
8	(DMA overrun error: not used)
9	DMA across 64 KByte boundary
0B	Bad track marker detected
10	ECC error
11	ECC error corrected
20	Disk controller error
40	Seek error

80 Disk controller timeout (not ready)
B9 Undefined error
FF Read status failure

AX and the flags are corrupted.

Comments

The **MP2500** implements all the standard ATA disk functions:

	PC Standard BIOS
00H	Reset disk system
01H	Get disk status
02H	Read disk sectors
03H	Write disk sectors
04H	Verify disk sectors
05H	Format disk cylinder
06H	Format bad track
07H	Format drive
08H	Get drive parameters
09H	Initialise drive parameters
0AH	Read long sector
0BH	Write long sector
0CH	Seek to cylinder
0DH	Alternate reset
0EH	Read test buffer
0FH	Write test buffer
10H	Test drive ready
11H	Recalibrate drive
12H	Controller RAM diagnostic
13H	Controller drive diagnostic
14H	Controller internal diagnostic
15H	Get disk type
16H	Change diskette
17H	Set diskette type
18H	Set media type (diskette)
19H	Reserved

Reset disk

Entry AH=00H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Recalibrates the specified hard disk drive's heads and the diskette subsystem.

Read disk status

Entry AH=01H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status

Description Returns status of the last disk operation.

Read sectors

Entry AH=02H
AL=no. of sectors
BX=offset of read data buffer
ES=segment of read data buffer
DH=head no.
DL=80H (drive 0) or 81H (drive 1)
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.

Exit CF=error flag
AH=status
AL=no. of sectors read

Description Reads the specified sectors to the buffer. These sectors may be on multiple tracks.

If the operation was successful, CF=0 and AH=0. If the operation was unsuccessful, CF=1 and AH=status byte.

Write sectors

Entry

AH=03H
AL=no. of sectors
BX=offset of write data buffer
ES=segment of write data buffer
DH=head no.
DL=80H (drive 0) or 81H (drive 1)
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.

Exit

CF=error flag
AH=status
AL=no. of sectors written

Description

Writes the specified sector(s) from the buffer.

If the operation was successful, CF=0 and AH=0. If the operation was unsuccessful, CF=1 and AH=status byte.

Verify sectors

Entry

AH=04H
AL=no. of sectors
DH=head no.
DL=80H (drive 0) or 81H (drive 1)
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.

Exit

CF=flag
AH=status
AL=no. of sectors verified

Description If the sector(s) verified correctly, CF=0 and AH=0. If the sector(s) did not verify, CF=1 and AH=status byte.

Format disk cylinder

Entry
AH=05H
AL=no. of sectors
BX=offset of format data buffer
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DH=head no.
DL=80H (drive 0) or 81H (drive 1)
ES=segment of format data buffer
ES:BX=ptr to list of address fields

Exit
CF=error flag
AH=status

Description Formats the sectors specified by the format buffer. This contains a four byte entry for each sector to format:

Byte1=track no
Byte2=head no.
Byte3=sector no.
Byte4=sector size

If the track(s) formatted correctly, CF=0. If the track(s) did not format correctly, CF=1 and AH gives the cause.

Sector sizes are as follows:

0=128 bytes
1=256 bytes
2=512 bytes
3=1024 bytes

Other information required for formatting (such as gap length, filler byte and sectors per track) is obtained from the appropriate disk parameter table.

Format bad track

Entry

AH=06H
AL=interleave factor
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DH=head no.
DL=80H (drive 0) or 81H (drive 1)

Exit

CF=error flag
AH=status

Description

Formats the track specified by CX, setting the bad sector flag for each sector.

If the track formatted correctly, CF=0. If the track did not format correctly, CF=1 and AH gives the cause.

Other information required for formatting is obtained from the appropriate disk parameter table.

Format drive

Entry

AH=07H
AL=interleave factor
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DL=80H (drive 0) or 81H (drive 1)

Exit

CF=error flag
AH=status

Description

Formats the entire drive specified by DL, starting at the cylinder number specified by CH.

If the drive formatted correctly, CF=0. If the drive did not format correctly, CF=1 and AH gives the cause.

Other information required for formatting is obtained from the appropriate disk parameter table.

Read drive parameters

Entry
AH=08H
DL=80H (drive 0) or 81H (drive 1)

Exit
CF=error flag
AH=status
CH=LSB of max cylinder no.
CL bits 0..5=max number of sectors per track
CL bits 6..7=MSB of max cylinder no.
DH=max head no.
DL=no. of hard disks
ES:DI=address of fixed disk parameters table

Description
Returns information about the specified hard disk.

Initialise drive parameters

Entry
AH=09H
DL=80H (drive 0) or 81H (drive 1)

Exit
CF=error flag
AH=status

Description
Initialises the controller for the specified hard disk.

Read long sector

Entry
AH=0AH
AL=number of sectors
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DH=head no.
DL=80H (drive 0) or 81H (drive 1)
ES:BX=disk transfer address

Exit
CF=error flag
AH=status

Description Reads the number of sectors specified by AL from the location specified by CX, using the head specified by DH and the drive specified by DL. The data is written to the location specified by ES:BX. This function also reads the ECC or CRC associated with these sectors.

Write long sector

Entry
AH=0BH
AL=number of sectors
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DH=head no.
DL=80H (drive 0) or 81H (drive 1)
ES:BX=disk transfer address

Exit
CF=error flag
AH=status

Description Writes the number of sectors specified by AL to the location specified by CX, using the head specified by DH and the drive specified by DL. The data is read from the location specified by ES:BX. This function also writes the ECC or CRC associated with these sectors.

Seek to cylinder

Entry
AH=0CH
CH=LSB of cylinder no.
CL bits 0..5=sector no.
CL bits 6..7=MSB of cylinder no.
DH=head no.
DL=80H (drive 0) or 81H (drive 1)

Exit
CF=error flag
AH=status

Description Positions the disk head specified by DH over the cylinder specified by CX, on the drive specified by DL.

Alternate reset disk

Entry AH=0DH
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Recalibrates the specified disk drive's heads without resetting the diskette system.

Read test buffer

Entry AH=0EH
DL=80H (drive 0) or 81H (drive 1)
ES:BX=pointer to diagnostic buffer

Exit AH=status
CF=error flag

Description Reads a test buffer from the specified fixed disk controller into the diagnostics buffer specified by ES:BX. Data is NOT read from the actual disk drive.

Write test buffer

Entry AH=0FH
DL=80H (drive 0) or 81H (drive 1)
ES:BX=pointer to diagnostic buffer

Exit AH=status
CF=error flag

Description Writes a test buffer to the specified fixed disk controller from the diagnostics buffer specified by ES:BX. Data is NOT written to the actual disk drive.

This function should be called before using function 05H to format the drive.

Test for drive ready

Entry AH=10H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Checks if the drive specified by DL is ready and can process a command.

Recalibrate drive

Entry AH=11H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Positions head 0 over cylinder 0 on the drive specified by DL.

Controller RAM diagnostic

Entry AH=12H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Causes the fixed disk controller to carry out a built-in diagnostic test on its internal sector buffer. AH indicates whether or not it passed this test.

Controller Drive diagnostic

Entry AH=13H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Causes the fixed disk controller to carry out diagnostic tests on the specified drive. AH indicates whether or not it passed this test.

Controller internal diagnostic

Entry AH=14H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=status
CF=error flag

Description Causes the fixed disk controller to carry out a built-in diagnostic self-test. AH indicates whether or not it passed this test.

Get disk type

Entry AH=15H
DL=80H (drive 0) or 81H (drive 1)

Exit AH=disk type
CX:DX=number of 512 byte sectors if AH=3

Description Gets the drive type in AH:
0=drive not present
3=fixed disk

If AH=3, CX and DX give the number of 512-byte sectors.

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25. INT 14H, Serial Port Handler

Use

Serial port control and I/O.

Entry

AH selects the function required, while other registers are used for parameters, as follows.

DX indicates the serial port. As **MP2500** is equipped with only one, COM2, DX must be 01H (COM2).

Exit

Valid only when using IBM mode comms, not when in **HUSKY** mode. On exit from many of the functions, the AX register indicates the communications status as follows, while the other registers are preserved.

Bits in AH indicates the line status as follows, when set:

Bit	Significance if set
7	Timeout (ignore other bits)
6	Transmit shift register empty
5	Transmit hold register empty
4	Line Break detected
3	Framing error
2	Parity error
1	Overrun error
0	Data ready (or in input buffer, if enabled)

Bits of AL indicate the modem handshake status as follows, when set:

Bit	Significance
7	Receive line signal detect
6	Ring Indicator (RI) – **Not supported by MP2500**
5	Data Set Ready (DSR)
4	Clear To Send (CTS)
3	Delta Receive line signal detect
2	Trailing edge RI (Ring Indicator) – **Not supported by MP2500**
1	Delta DSR 0 Delta CTS

Comments

IBM PC BIOS provides five functions:

00H Initialise port
01H Send a character
02H Receive a character
03H Get port status
04H Extended initialise port (PS/2-compatible)

MP2500 BIOS provides identical functions, plus a number of extensions, providing access to additional facilities such as higher speeds and protocols, listed below. The functions marked with an asterisk (*) are ignored by **MP2500** but **ARE** supported by **FS3** - see Appendix G for more information.

1EH Read communications parameters
1FH No effect
20H Select communications parameters
21H Extended control
22H Extended status
23H Control handshaking
24H Reserved
25H Reserved
26H Ignored *
27H Get installed protocols count
28H Get protocol name
29H Get protocol handle
2AH Extended protocol menu

2BH Get extended protocol parameters
2CH Reserved
2DH Reserved
2EH Ignored *
2FH Ignored *
31H Reserved
32H Ignored *
33H Ignored *
34H Reserved
35H Control NMI suspend after data reception
36H Control NMI suspend after data transmission
37H Ignored *
38H Ignored *

Initialise port

Entry AH=00H
DX=port, 01H (COM2)
AL=parameters

Exit AX=status

Description Configures the port specified by DX, according to the bits sets in AL:

D7	D6	D5	Baud
0	0	0	110
0	0	1	150
0	1	0	300
0	1	1	600
1	0	0	1200
1	0	1	2400
1	1	0	4800
1	1	1	9600

D4	D3	Parity
0	0	None
0	1	Odd
1	0	None
1	1	Even

D2	Stop bits
0	One
1	Two

D1	D0	Data bits
0	0	7
0	1	7
1	0	7
1	1	8

Send character

Entry AH=01H
AL=character
DX=port, 01H (COM2)

Exit AX=status

Description Write the character to the port specified by DX.

On return, if bit 7 of AH is 0, the character was sent, otherwise AX indicates the reason for non-transmission. (To check if the reason was a timeout, you must use the 'Check status' function.)

Input character

Entry AH=02H
DX=port, 01H (COM2)

Exit AH=status
AL=character

Description Reads a character from the port specified by DX.

If AH=0, the character has been read correctly and is in AL. Otherwise, AH indicates the reason for failure.

Check status

Entry AH=03H
DX=port, 01H (COM2)

Exit AH=line status
AL=modem status

Description Reads the RS232 line and modem status into AX.

Extended initialise port [+]

Entry AH=04H
DX=port, 01H (COM2)
BH=parity
BL=stop bits
CH=data bits
CL=baud rate

Exit AX=status

Description Configures the port specified by DX, according to the other registers:

CL	Baud rate
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200
9	38400
	(see Note below)

Note: 38400 Baud is **not** recommended for **MP2500.**

BH	Parity
0	None
1	Odd
2	Even
3	Odd
4	Even

BL	Stop bits
0	One
1	Two

CH	Data bits
0	7
1	7
2	7
3	8

Read comms parameters [+]

Entry

AH=1EH
DS=segment address of buffer
BX=offset address of buffer
CX=channel number (01H=COM2)

Exit Returns nothing

Description Reads the configuration of the port specified by CX into the buffer specified by DS:BX. This information takes the following format:

Byte 0	Effect
0	IBM communications
non 0	**HUSKY** communications

Byte 1	Port number
1	COM2

Byte 2	Baud rate
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200
9	38400 (see note below)

Note: 38400 Baud is **not** recommended for **MP2500.**

Byte 3	Data bits
1	7
2	8

Byte 4	Parity
0	None
1	Odd
2	Even

Byte 5	Stop bits
0	One
1	Two

Byte 6	Handshake
D7	ignored
D6=1	DCD enable
D5=1	DSR enable
D4=1	CTS enable
D3	ignored
D2=1	DTR enable
D1,D0=00	RTS off
D1,D0=01	RTS hold
D1,D0=10	RTS true
D1,D0=11	ignored

Byte 7	Protocol
0	None
1	XON/XOFF
2	Not used (**obsolete** option)

Byte 8	Nulls
0..14H	0..20 Nulls after CR

Byte 9	LF
0	Off
1	On

Byte 10	Serig
0..7FH	Ignore this character
80H	Off

Byte 11	Echo
0	Off
1	On

Byte 12	Transmit timeout
0	Off
1..3CH	1..60 seconds

Byte 13	Receive time-out
0	Off
1..3CH	1..60 seconds

For details of **HUSKY** communications, see Part 2.

Select comms parameters [+]

Entry

AH=20H
DS=segment address of buffer
BX=offset address of buffer
CX=channel number (01H=COM2)

Exit

AX=0 - OK
AX=1 - invalid parameter(s)

Description

Configures the port specified by CX and byte 1 of the buffer, according to the contents of the buffer specified by DS:BX. Note that both CX and byte 1 must specify the same buffer.

This buffer takes the following format:

Byte 0	Effect
0	Select IBM communications
non 0	Select **HUSKY** communications

Byte 1	Port number
0	COM1
1	COM2

Byte 2	Baud rate
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600
8	19200
9	38400 (see Note below)

Note: 38400 Baud is **not** recommended for **MP2500.**

Byte 3	Data bits
1	7
2	8

Byte 4	Parity
0	None
1	Odd
2	Even

Byte 5	Stop bits
0	One
1	Two

Byte 6	Handshake
D7	ignored
D6=1	DCD enable
D5=1	DSR enable
D4=1	CTS enable
D3	ignored
D2=1	DTR enable
D1,D0=00	RTS off
D1,D0=01	RTS hold
D1,D0=10	RTS true
D1,D0=11	ignored

Byte 7	Protocol
0	None
1	XON/XOFF
2	Not used (**obsolete** option)

Byte 8	Nulls
0..14H	0..20 Nulls after CR

Byte 9	LF
0	Off
1	On

Byte 10	Serig
0..7FH	Ignore this character
80H	Off

Byte 11	Echo
0	Off
1	On

Byte 12	Transmit timeout
0	Off
1..3CH	1..60 seconds

Byte 13	Receive time-out
0	Off
1..3CH	1..60 seconds

Byte 14	**RESERVED**
Byte 15	**RESERVED**
Byte 16	**RESERVED**
Byte 17	**RESERVED**
Byte 18	**RESERVED**

For details of **HUSKY** communications, see Part 2.

Extended control [+]

Entry

AH=21H
AL=command (bit0=empty RX, bit1=empty TX, bit2=force TX)
DX=port, non 0 (COM2)

Exit

AH=extended status (see 'Extended status', below)

Description

Used to control buffering. The commands are selected as follows:

Bit	Contents	Resulting Action
0	1	empties RX buffer
1	1	empties TX buffer
2	1	forces transmit

Extended status [+]

Entry AH=22H
DX=port, non 0 (COM2)

Exit AH=extended status
BX=number of characters in input buffer
CX=number of characters in output buffer

Description Used to obtain detailed error information from the current protocol, including the status of the transmit and receive buffers.

The standard protocols (NONE and XON/XOFF) return the most recent error code in AH. For details of the status information returned by other protocols, refer to the protocol documentation.

Protocols will also return error information in the RS232 status byte returned by the standard functions, using the bits which most closely approximate the error they need to report.

Control handshake lines [+]

Entry AH=23H
BH=line
BL=level
DX=port, 01H (COM2)

Exit Returns nothing

Description Can be used to control the DTR and RTS handshake output lines directly, for the port specified by DX. The specified level remains latched until changed by use of this function or normal communications handshaking.

BH	BL	Effect
0	0	set RTS low
0	1	set RTS high
1	0	set DTR low
1	1	set DTR high

Control RI power up [+]

Entry AH=26H
AL=control (0=enable, non 0=disable)

Exit Returns nothing

Description Ring Indicator (RI) is **not** supported by **MP2500**.

Get installed protocols count [+]

Entry AH=27H
AL=count of extended protocols installed

Exit AL=previous value of protocol count + number of resident installed protocols

Description The purpose of this function is to determine how many protocols are currently installed in **MP2500**. It is used by the UTIL comms menu option to determine how many protocols can be chosen from.

Get protocol name [+]

Entry AH=28H
AL=protocol handle
DS:BX=pointer to 8 character buffer

Exit AH=status (0=pass, FFH=fail)

Description Use this function to read the name of the protocol with the handle stored in AL. On return, if AH is 0 the name is in the 8 character buffer pointed to by DS:BX.

Get protocol handle [+]

Entry AH=29H
DS:BX=pointer to buffer containing name

Exit AH=status (0=pass, FFH=fail)
AL=handle

Description Use this function to read the handle for the protocol whose name is stored in the buffer pointed to DS:BX. On return, the handle is in AL if AH is 0.

Extended protocol menu [+]

Entry AH=2AH
AL=protocol handle

Exit AH=status (0=pass, FFH=fail)
AL=handle

Description Use this function to configure the protocol specified by the handle in AL, by displaying a menu.

Get extended protocol parameters [+]

Entry AH=2BH
AL=protocol handle
DS:BX=pointer to parameter buffer

Exit AH=status (0=pass, FFH=fail)

Description Use this function to read parameters for the protocol with the handle stored in AL. On return, if AH is 0 the parameters are in the buffer pointed to by DS:BX.

Control NMI suspend after data reception [+]

Entry AH=35H
AL=control (0=disable, non-0=enable)

Exit Returns nothing

Description Use this function to enable or disable a 2 second suspension of NMIs after the last data received during polled comms.

This function is highly specialised and not for general use!

Control NMI suspend after data transmission [+]

Entry AH=36H
AL=control (0=disable, non-0=enable)

Exit Returns nothing

Description Use this function to enable or disable a 2 second suspension of NMIs after the last data transmission during polled comms.

This function is highly specialised and not for general use!

26. INT 15H, BIOS Extension Functions [+]

Use

Provides access to additional **MP2500**-specific BIOS functions. These facilities are as follows. The functions marked with an asterisk (*) are ignored by **MP2500** but **ARE** supported by **FS3** - see Appendix G for more information.

60H Reserved
61H Ignored *
62H Ignored *
63H Get/set idle timeout
64H Control Resume mode
65H Ignored *
66H Ignored *
67H Control STOP mode

68H Power down
69H Control power down
6AH Reserved
6BH Get ROM BIOS version number
6CH Get serial number
6DH Get event details
6EH Enable/trap event
6FH Acknowledge event

70H Control sound
71H Reserved
72H Redirect serial number
73H Ignored *
74H Set backlight (option) power up state
75H Set contrast power up state
76H Control power save
77H Reserved

78H Reserved
79H Select serial port for redirected printing
7AH Invoke HOT key
7BH Control HOT key
7CH Control HOT key power option
7DH Override power warnings
7EH Ignored *
7FH Ignored *

80H Ignored *
81H Ignored *
82H Sound output
83H Control screen synchronisation
84H Get/set diskette drive
85H Ignored *
86H Set attribute table
87H Set INT 72H vector

88H Reserved
89H Ignored *
8AH Control power input
8BH Reserved
8CH Get/set power save entry flag
8DH Ignored *
8FH Reserved

90H Ignored *
91H Reserved
92H Reserved
93H Get charging status
94H Reset machine information
95H Get machine information
96H Ignored *
97H Reserved

98H Select soft/default font
99H Get unit serial number
9AH Get customer id
9BH Resynchronise timer tick with RTC
9CH Ignored *
9DH Select backlight (option) timeout mode
9EH Reserved
9FH Set 11x8 text font

A0H Set 16x16 text font
A1H Reserved
A2H Select printer port type
A3H Select INT 15H mode (see below)
A4H (duplicate of 80H)
A5H (duplicate of 81H)
A6H (duplicate of 82H)
A7H (duplicate of 83H)
A8H (duplicate of 84H)
A9H (duplicate of 85H)
AAH (duplicate of 86H)
ABH (duplicate of 87H)
ACH (duplicate of 89H)
ADH (duplicate of 90H)
AEH Get/set diskette drive port
AFH Enable/disable temperature override

Note: The following INT 15H functions are implemented by some AT BIOSes but are not supported by the **MP2500** BIOS: 4FH (keyboard intercept), 80H (device open), 81H (device close), 82H (program termination), 83H (set event wait interval), 84H (joystick), 85H (SysReq key), 86H (wait), 87H (move block), 88H (read extended memory size), 89H (protected mode), 90H (device busy), 91H (interrupt complete), C0H (system configuration address), C1H (extended BIOS data area address), C2H (pointing device).

Entry

AH selects the function required, while other registers are used for parameters.

Exit

Most of these functions return a status byte in AH, indicating success or failure of the operation:

AH	Operation
0	Successful
FF	Failed

Comments

In the IBM PC-AT and IBM PS/2 BIOS, INT 15 is used to implement a variety of enhancements (functions 80..91H).

On the **MP2500**, many of these functions are used to change the subsequent behaviour of the **MP2500**; behaviour remains changed until the next cold start, which restores the default (normal) behaviour. (A cold start is produced by a power up in non-resume mode or after using emergency breakout or losing all power.)

Get/set idle timeout [+]

Entry
AH=63H AL=0 (get) or 1 (set)
BX=time (0..0E10H) if set

Exit
AH=status
BX=time (0..0E10H) if get

Description

MP2500 will normally turn off automatically if left idle (no keyboard input or communications activity) for 5 minutes.

Use this function to get or set the idle timeout:

BX	Timeout
0	Do not timeout
1..0E10H	1 second to 3600 seconds

For optimum battery life, set the time as short as possible while still convenient to the user and application. It is not normally advisable to set BX to 0 (no timeout).

Control Resume mode [+]

Entry AH=64H
AL=control

Exit AH=status

Description **MP2500** will normally continue executing the current application when turned off and then turned on again, as if nothing had happened. This is 'resume mode'.

If resume mode is disabled, when **MP2500** is turned on it will display the 'Welcome' screen and boot MS-DOS. This is a cold start and will re-enable resume mode automatically (and set all other settings to their defaults).

Use this function to enable or disable resume mode:

AL	Effect
0	Disable resume mode
1	Enable resume mode

The default, restored by a cold start, is resume mode.

Control STOP mode [+]

Entry AH=67H
AL=mode

Exit AH=status

Description **MP2500** normally enters STOP mode when waiting for keyboard input, to conserve power, or HALT mode if communications is in progress.

Use this function to enable or disable STOP mode. With STOP mode disabled, HALT mode will be used instead, which uses more power but allows communications:

AL	Effect
0	Use STOP mode
1	Use HALT mode

The default, restored on cold start, is STOP mode.

Power down [+]

Entry AH=68H

Exit Returns nothing

Description If power down is allowed (see function 69H), this turns **MP2500** off. When **MP2500** powers up, it will either return to the application (if in resume mode) or boot MS-DOS (if not in resume mode).

If power down is not allowed, the function will return immediately.

For details of resume mode, see function 64H.

Control power down [+]

Entry AH=69H
AL=mode

Exit AH=status

Description This function can be used to prevent power down due to pressing the ⏻ key, the power down function (68H) or expiry of the idle timeout (see function 63H).

It cannot prevent power down due to power fail or low power.

AL	Effect
0	Inhibit power down
1	Allow power down

Get ROM BIOS version number [+]

Entry AH=6BH
DX=0

Exit BH=version number (ASCII)
BL=release number (ASCII)
CH=minor release number (ASCII)
CL=minor release number (ASCII)
DX=machine ID (1=**MP2500**, <>1=not **MP2500**)

Description Use this function to read the ROM BIOS version, release number and machine ID.

Get serial number [+]

Entry AH=6CH

Exit AH=0 (success)
BL=top 2 digits (BCD)
CX=least significant 4 digits (BCD)

Description Use this function to read the serial number. Normally, it will read the number from the unit's ROM, which is the same on every **MP2500** and not very useful. However, you can store a different serial number in RAM and make this function read the RAM version instead, by using function 72H.

Note: For most purposes, it's easier to read the real unit serial number by using function 99H (get unit serial number), as that is guaranteed to be unique and needs no setting up.

Serial numbers can be used to identify the unit in which the program is running (eg for copy-protection purposes).

Get event details [+]

Entry AH=6DH

Exit

BX=event flags, bits 0..15
CX=event flags, bits 16..31

Description

The events mechanism provides an easy way to detect important events such as the RTC alarm going off or special keys being pressed.

Use this function to read the events status. Any enabled events which have occurred but not yet been acknowledged (see function 6FH) will be indicated by setting the appropriate bits in BX and CX (ie event 0 is bit 0, event 1 is bit 1, etc):

Event	Description
0	ⓘ pressed**
1	Error on COM1
2	Error on COM2
3	Data received on COM1
4	Data received on COM2
5	RTC alarm
6	RI received – **not** supported on **MP2500**

** Or power down is imminent due to an idle timeout or low power warnings.

(Events are enabled by using function 6EH.)

Enable/trap event [+]

Entry

AH=6EH
AL=software interrupt no.
BH=event number
BL=enable mask

Exit

AH=0 (success)

Description

The events mechanism provides an easy way to detect important events such as the RTC alarm going off or special keys being pressed.

Use this function to enable or disable an event, or to trap the event. BH defines the event number to control, BL specifies whether to enable or disable that event:

BL	Effect
0	Disable (ignore) event
1	Enable event

Enabling an event replaces its normal effect. For example, if event 1 is enabled, an error on COM1 will not produce a communications error message. Instead, the corresponding event flag will be set or the trap for that event will be executed.

Disabling an event restores its normal effect. For example, a COM1 error will produce an error message and will no longer set that event flag or execute the trap defined for that event.

AL specifies whether to trap the event:

AL	Effect
0	Do not trap
1..FFH	Trap as software interrupt 1..255

If you trap an enabled event, the corresponding software interrupt will be called when the event occurs. You must define the interrupt service routine (by using the MS-DOS Set Vector function) before trapping the event.

The interrupt service routine MUST NOT execute any MS-DOS or BIOS interrupts and must be short. Typically, it will set a flag within the application which the application polls at regular intervals.

By default, all events are disabled and no events are trapped. The defaults are restored on a cold start.

Acknowledge event [+]

Entry AH=6FH
AL=event number

Exit AH=0 (success)

Description The events mechanism provides an easy way to detect important events such as the RTC alarm going off or special keys being pressed.

Use this function to acknowledge an event when you are about to service it. This resets the corresponding bit in the event status bytes, so you can detect the next occurrence of this event.

Control sound [+]

Entry AH=70H
AL=0 (disable) or non-0 (enable)

Exit Registers unchanged

Description Use this function to control (enable or disable) ALL sound output, whether instigated by an application or BIOS.

Redirect serial number [+]

Entry AH=72H
AL=0 (reset) or non-0 (set)
DS=segment address of serial number
BX=segment offset of serial number

Exit AH=0 (success)

Description By default, each **MP2500** has the same 6-digit serial number stored in ROM, but serial numbers can be stored in the RAM. These can then be used to identify the unit which a program is running on (eg for copy-protection purposes). These serial numbers are read by using function 6CH.

Use this function to change the serial number read routine so that it returns the serial number stored in the RAM, or reset it to read the standard serial number. Store the serial number as six consecutive bytes, with each byte specifying a decimal digit in ASCII (ie in the range 30H (0) to 39H (9)).

Note: More usefully, the unit's actual serial number can be read by using function 99H (get unit serial number).

The default, restored by a cold start, is to use the ROM serial number, which is identical on all units.

Set backlight (option) power up state [+]

Entry AH=74H AL=mode (1=off, 2=same level, 3=on)

Exit AH=status

Description If the backlight option is fitted, use this function to specify how the backlight should be set when **MP2500** is next turned on.

The default level, restored by a cold start, is 0.

Set contrast power up state [+]

Entry AH=75H
AL=mode (1=off, 2=same level, 3=level as BL)
BL=level (0..7FH)

Exit AH=status

Description Use this function to specify how the LCD contrast should be set when **MP2500** is next turned on.

The default level, restored by a cold start, is 0.

Control power save [+]

Entry AH=76H
BX=control

Exit Registers unchanged

Description **MP2500** enters power save modes under a variety of conditions. Use this function to control those conditions. BX defines the conditions. If bit 0 is 0, **MP2500** will not enter power save; if bit 0 is 1, power save is enabled but individual causes can be inhibited by setting bits 1 to 3. Default is 11H.

Bit	
D0=0	**MP2500** will not enter power save
D0=1	power save is enabled and following conditions apply:

Bit	**Inhibits power save:**
D1=1	If waiting for data from COM1
D2=1	If waiting for data from COM2
D3=1	Reserved
D4=1	Inhibit power up on timer tick

MP2500 leaves power save mode briefly about 2.5 times a second (to service the NMI). Setting bit D4 will inhibit this, **but this is not recommended**.

By default, all power save causes are enabled. This default is restored by a cold start.

Select serial port for redirected printing [+]

Entry AH=79H
AL=port (1=COM2)

Exit Returns nothing

Description Selects which serial port to redirect printing to from the parallel port. The default, restored by a cold start, is to use COM2.

Note This function only allows selection of COM2 on the standard **MP2500**.

Invoke HOT key [+]

Entry AH=7AH

Exit AH=00 always returned.
CF=00 always returned.

Description Invokes the HOT key function just like pressing the HOT key (🐾H on the default keyboard). Access is controlled by functions 7BH (inhibit all access) and 7CH (inhibit access to power functions), exactly as if the user pressed the HOT key.

Control HOT key [+]

Entry AH=7BH
AL=control (0=prevent, non 0=allow)

Exit AH=00 always returned.
CF=00 always returned.

Description The HOT key allows users to examine and change various aspects of **MP2500**'s set-up. Use this function to prevent access to these facilities.

By default, access is enabled. This default is restored by a cold start.

If you only want to prevent access to the power control facilities, use function 7CH.

Control HOT key power option [+]

Entry AH=7CH
AL=control (0=prevent, non 0=allow)

Exit Returns nothing

Description The HOT key power option allows users to enable or disable the battery charging. Use this function to prevent access to this facility while allowing normal use of the other HOT key menu options.

By default, access is enabled. This default is restored by a cold start.

If you want to prevent access to all the HOT key facilities, use function 7BH.

Override low power turn off [+]

Entry AH=7DH
AL=control (0=turn off after 10 warnings non-0=never turn off)

Exit Returns nothing

Description **MP2500** will normally turn off after issuing 10 consecutive low power warnings. Use this function to disable this automatic power down, while still displaying the warnings. This prolongs use a little in emergency situations. The **MP2500** will still turn off when the battery voltage becomes too low to operate the unit.

By default, power down is enabled. This default is restored by a cold start.

On **MP2500**, low power warnings are issued if the battery voltage falls below a fixed threshold.

Sound output [+]

Entry AH=82H
BX=pitch
DX=length

Exit Returns nothing

Description Use this function to sound a tone of a specified pitch (BX) and duration (DX). These parameters are summarised in the following table.

CAUTION: The **MP2500** sounder is designed to provide maximum volume at 2KHz and may be too quiet at other frequencies. Check before using this function in an application.

The length parameter, DX, can be calculated from the following formula:

$$DX = \frac{\text{duration} \times 666670}{\text{frequency}}$$

Sound interrupt pitch parameters

BX (dec)	Note	Frequency (dec)	BX (dec)	Note	Frequency (dec)
4803	C	138.810	1430	A#	466.162
4668	C#	142.827	1350	B	493.880
4540	D	146.830	1274	C	523.250
4286	D#	155.560	1203	C#	554.365
4045	E	164.810	1135	D	587.330
3818	F	174.610	1071	D#	622.257
3604	F#	184.996	1011	E	659.260
3401	G	196.000	954	F	698.460
3210	G#	207.654	901	F#	739.990
3030	A	220.000	850	G	783.990
2860	A#	233.081	803	G#	830.609
2700	B	246.940	758	A	880.000
2548	MID C	261.630	715	A#	932.329
2405	C#	277.183	675	B	987.770
2270	D	293.660	637	C	1046.500
2143	D#	311.127	601	C#	1108.749
2022	E	329.630	568	D	1174.700
1909	F	349.230	536	D#	1244.523
1802	F#	369.998	506	E	1318.500
1701	G	392.000	477	F	1396.900
1605	G#	415.307	451	F#	1479.503
1515	A	440.000	425	G	1568.000

For example, to sound middle C for 0.5 seconds, set DX to 1274 decimal and BX to 2548 decimal.

Control screen synchronisation [+]

Entry AH=83H
AL=0 (disable) or non 0 (enable)

Exit Returns nothing

Description The LCD screen window normally tracks screen output to keep the cursor in view. Use this function to enable or disable this screen synchronisation. (For example, you could disable synchronisation if using standard software that moves the cursor to unimportant areas of the screen.)

The default state is enabled. This default is restored by a cold start. Users can also control synchronisation by using the HOT key.

Get/set diskette drive port - 84H

Entry AH=84H
AL=0 (get) or non-0 (set)
BL=0 (COM2)

Exit If get, AL=0 (COM2)
If set, nothing is returned

Description This function is ignored on **MP2500** as there is no Fischer connector, the diskette drive can only be connected via COM2 (the serial port).

Get/set screen attribute table [+]

Entry AH=86H
AL=0 (get) or non 0 (set)
DS:SI=start of attribute table buffer
BX=1234H

Exit AH=0 buffer contains attribute table, if get

Description

If you set AL to 0, this function will read the attribute table into the 256 byte buffer pointed to by DS:SI. If you set AL to non-zero, the attribute table will be set to the contents of this buffer.

The first entry in the table is for text attribute 00H, the second for text attribute 01H and so on. Whenever a character is displayed, its character dot data is XORed with the appropriate entry in the table and the result is displayed.

For example, if a character has the attribute 01H and entry 01H in the table is 00H, the character will be displayed as normal; if the entry is FFH, the character will be displayed as inverse video.

The dot data is XORed a row at a time, with the least significant bits of the entry. For example, if the entry is 0FH (00001111), the righthand four pixels of the character will be reversed. In 8x8 mode, the righthand half will be reversed, while in 8x6 mode the righthand two thirds will be reversed.

Users can also select the particular attribute combination to display as reversed, by using the HOT key. This will override changes made by using this function, but you can prevent access by using INT 15 function 7BH.

Note that this function has no effect in graphics modes, since there are no text attributes in graphics modes.

Control power input [+]

Entry

AH=8AH
AL=0 (disable) or non 0 (enable)
SI=1234H (password)
DI=5678H (password)

Exit

AH=00H (success) or 0FFH (failure)

Description Use this function to enable or disable power input from the AC adaptor. When power input is disabled, the AC adaptor will not charge batteries or supply power to **MP2500**. This should be used if Alkaline batteries are fitted.

Notes:

1. For this function to operate correctly you must also set SI and DI as indicated.

2. This function will fail if Battery Charging Support has been disabled in UTIL.

The default, restored on a cold start, is to enable power input.

Get/set power save entry flag [+]

Entry AH=8CH
AL=0 (get) or non 0 (set)
BX=mask, if set

Exit BX=current mask, if get

Description **MP2500** normally enters power save mode to conserve power whenever possible, for example, if an application is waiting for keyboard input. However, it will not do so if an application is repeatedly accessing other BIOS services since this indicates that it is doing more than waiting for user input.

You can use this function to optimise the use of power save mode and so extend battery life.

To allow entry to power save mode even while such accesses are being made, use this function. Set bits in BX to 0 to indicate which services should not prevent power save entry, as follows:

Bit	Service
0	INT 10H (screen services)
1	INT 13H (disk services)
2	INT 14H (comms services)
3	INT 15H (BIOS extension services)
4	INT 1AH (time/date services)
5	INT 21H (DOS services)
6	Direct write to video RAM
7	Access to 8250 UART
8	Access to 8253 (sound)

The default mask (FFFFH) is restored on a cold start, to prevent power save if any of these services is being used.

Get charging status [+]

Entry AH=93H

Exit AH=0 (success)
AL=0 (not charging) or non 0 (charging)
If charging:
BH=0 (not boost - see below*****)
BL=0 (standard **MP2500** charging)
CH=0 (normal current) or non 0 (trickle)
CL=7FH (standard **MP2500** charging)

Description Use this function to check the charging status.

***Note** that **MP2500** does not support boost charging.

Reset machine information [+]

Entry AH=94H

Exit AH=0 (success) non 0 (failure)

Description Use this function to initialise or restart the machine information. See function 95H for details.

Get machine information [+]

Entry
AH=95H
ES=segment of buffer pointer
BX=offset of buffer pointer

Exit
AH=0 (success) non 0 (failure)
Buffer format, all numbers in BCD:
dd - day when machine information last reset
mm - month " "
yy - year " "
nn - number of resets
nn - reserved
nn - reserved

Description
Use this function to read the machine information listed above, to keep a check on how the **MP2500** has been used. You should use function 94H to initialise the information before providing the machine to a user, and can also use it to reset the information at later times if you wish.

Select soft/default font [+]

Entry
AH=98H
AL=control (0=default, non 0=custom font)
DS:BX=segment:offset of custom font table

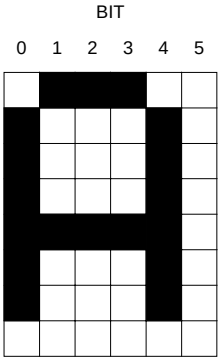
Exit
AH=0 (success)

Description
Use this function to select a custom font for text mode in place of the definitions used for the 6x8 fonts and the fonts based on it (12x8 and 12x16), or to return to the default definitions. Doing so also resets the bold attribute mask to 00H so that the bold font is not used (use INT 10H function 7BH).

You must supply a font table for the normal font in the 640K base RAM area with the following format:

Byte 0 - the top row of ASCII 0
Byte 1 - the top row of ASCII 1
..
Byte 255 - the top row of ASCII 255
Byte 256 - the second row of ASCII 0
etc, etc.

The table must define all 256 characters, for the 6x8 font (the BIOS derives the other fonts from the 6x8 definitions). Within each byte, the bit order is reversed, ie bit 0 defines the leftmost pixel, bit 1 the next, and so on. Bits 6 and 7 should be set to 0 as the characters are only six pixels wide. For example, the definition of ASCII 65 (A) might look like this:



So the definition for A in this example is:

start +041H = 00001110
start +141H = 00010001
start +241H = 00010001
start +341H = 00010001
start +441H = 00011111
start +541H = 00010001
start +641H = 00010001
start +741H = 00000000

If you want to use the bold font, load its definition table into memory immediately after the end of the normal font table ie exactly 800H after its start. Remember to set the bold attribute mask (with INT 10H function 7BH) AFTER selecting the custom font.

Note: The application should select the default font again before exiting, as the next application will probably overwrite the custom font table, producing a scrambled display on the LCD.

The default, restored on a cold start, is to use the default font.

Get unit serial number [+]

Entry
AH=99H
ES:DI=pointer to buffer

Exit
AH=0 and CF=0 (success) and buffer contains:
byte 0: length of serial number
byte 1..16 (max): serial number
OR
AH=0FFH and CF=1 (failure) and buffer is unchanged

Description Use this function to read the **MP2500**'s unit serial number into the specified buffer. The unit serial number is the same as shown on the unit's label.

Note that the unit serial number is quite distinct from the serial number accessed by functions 6CH and 72H.

Get customer id [+]

Entry AH=9AH
ES:DI=pointer to buffer

Exit AH=0 and CF=0 (success) and buffer contains:
byte 0: length of customer id
byte 1..8 (max): customer id
OR
AH=0FFH and CF=1 (failure) and buffer is unchanged

Description Use this function to read the customer id from the **MP2500**'s EPROM, into the specified buffer. This id can be programmed for you or by using a special utility. Contact your supplier for details. The function will fail if the customer id has not been set.

Resynchronise system clock with RTC [+]

Entry AH=9BH

Exit Returns nothing

Description Use this function to set the system clock to exactly the same time as the RTC.

Backlight (option) timeout mode [+]

Entry AH=9DH
AL=0 (set resume after timeout mode)
AL=1 (set stay off after timeout mode)
AL=80H - read current mode

Exit If read:
AL=0 (resume after timeout)
AL=1 (stay off after timeout)

Description If the optional backlight is fitted, use this function to change or check how the backlight timeout is handled, according to the contents of AL. If AL=0 that after the backlight timeout, when the user presses a key the backlight will turn on again. If AL=1 then the backlight will stay off. If AL=80H, this function returns the current setting in AL.

Note: Use AL=1 (stay off after timeout) to maximise battery life.

Set 11x8 text font [+]

Entry AH=9FH
AL=0 reset to default (BIOS) font
AL=non-0 use custom font
DS:BX = segment:offset of font table

Exit Registers unchanged

Description Use this function to select a custom font in place of the standard definition for the 11x8 font, or to return to the standard definition.

You must supply a font table in the 640K base RAM area in the following format:

Word 0 = top row of ASCII 0
Word 1 = top row of ASCII 1
...Word 255 = top row of ASCII 255
Word 256 = second row of ASCII 0
etc, etc

The table must define all 256 characters. Within each word, the bit order is reversed, ie bit 0 defines the leftmost pixel, bit 1 the next, and so on. Bits 11 to 15 should always be set to 0 as the font is only 11 pixels wide, not 16.

Note: The application should select the default font again before exiting, as the next application will probably overwrite the custom font table, producing a scrambled display on the LCD.

The default, restored on a cold start, is to use the default font.

Set 16x16 text font [+]

Entry
AH=A0H
AL=0 disable (use 6x8 font)
AL=non-0 use custom font
DS:BX = segment:offset of font table

Exit Registers unchanged

Description Use this function to define a custom 16x16 font, or to disable the custom font (and use 6x8 in its place).

You must supply a font table in the 640K base RAM area in the following format:

Word 0 = top row of ASCII 0
Word 1 = next row of ASCII 0
...Word 15 = bottom row of ASCII 0
Word 16 = top row of ASCII 1
etc, etc

The table must define all 256 characters. Within each word, the bit order is reversed, ie bit 0 defines the leftmost pixel, bit 1 the next, and so on.

Note: The application should select the default font again before exiting, as the next application will probably overwrite the custom font table, producing a scrambled display on the LCD.

The default, restored on a cold start, is to disable the custom font.

Get/set Printer port type

Entry AH=A2H
AL= 0 (get) or non-0 (set)
BL=0 (use serial port)

Exit If set, nothing is returned
If get, AL=0 (serial port type)

Description Use this function to set or check which type of port to use for printing via LPT1: on the standard **MP2500**, the only port that can be used is the serial port, COM2.

The default is to use the serial port, COM2. No other printer port types can be selected.

Select INT 15H mode

Note that for this function, **FS3** and **MP2500** are synonymous.

Entry AH=A3H
AL= (0=**FS3**, 1=**FS3** only, 2=AT only)

Exit Returns nothing

Description This function selects which subset of overlapping INT 15H sub functions are accessed by their normal (80H..91H) numbers. The mode parameter has the following effects:

FS3 mode (default):

Func	Route	Description
24H	AT	Indicate port 92 a20 gate support
87H	AT	Move memory block in protect mode
88H	AT	Get amount of XMS (extended) memory
C0H	AT	Get AT config parameters

FS3 only mode:

Func	Route	Description
24H	AT	Indicate port 92 a20 gate support
C0H	AT	Get AT config parameters

AT only mode:

Func	Route	Description
24H	AT	Indicate port 92 a20 gate support
00H--03H	AT	Obsolete cassette functions
80H--89H	AT	Various AT functions
90H	AT	Device busy
91H	AT	Interrupt complete
C0H	AT	Get AT config parameters

FS3 functions not found in the table which overlap can be accessed by using duplicate AH values A4H to ADH as listed below.

Duplicated Functions

A4H Set battery capacity	(duplicate of 80H)
A5H Control power output	(duplicate of 81H)
A6H Sound output	(duplicate of 82H)
A7H Control screen sync	(duplicate of 83H)
A8H Get/set diskette drive	(duplicate of 84H)
A9H Set/restore power menu	(duplicate of 85H)
AAH Set attribute table	(duplicate of 86H)
ABH Set INT 72H vector	(duplicate of 87H)
ACH Get/set pwr manage mode	(duplicate of 89H)
ADH Set power out m/s duration	(duplicate of 90H)

Get/set diskette drive port

Entry
AH=AEH
AL=0 (get) or non-0 (set)
BL=0 (port1)

Exit
If get, AL=0 (port1)
If set, nothing is returned

Description
This function selects which port to use as the diskette drive serial port. On the standard **MP2500**, there is only one serial port - Port1 (COM2).

Enable/disable temperature override

Entry AH=AFH
AL=0 (disable) or non-0 (enable)

Exit Returns nothing

Description The **MP2500** will normally prevent charging and fast discharge outside the range 0°C to 40°C (32°F to 104°F nominal), as a safety measure.

Use this function to enable or disable this temperature override.

CAUTION: Only invoke this function under special circumstances. It is not normally advisable to charge rechargeable batteries at high or low temperatures. At low temperatures there is a risk of Hydrogen gas emission, while frequent charging at high temperatures may reduce battery longevity.

The default, restored on a cold start, is to enable the charging temperature override.

27. INT 16H, Keyboard Handler

Use

Keyboard input and status.

Entry

AH selects the function required, as follows.

Exit

The AX register returns results as shown in the following descriptions. All other registers are preserved. The flags are corrupted.

Comments

The IBM PC BIOS provides the following functions:

00H	Get key	05H	Write to keyboard buffer
01H	Get status	10H	Extended read keystroke
02H	Get shift status	11H	Get extended status
03H	Set key repeat	12H	Get extended shift status

The **MP2500** BIOS provides these functions and also supports a number of extensions, providing access to the following facilities:

20H	Set temporary shift
21H	Control shift keys
22H	Control Ctrl-Alt-Del
23H	Control emergency breakout
24H	Redefine key codes
25H	Reset keyboard
26H	Control keyclick
27H	Reserved
28H	Reserved
29H	Get key repeat
2AH	Control key repeat

2BH	Redefine key scan codes
2CH	Redefine PAW key codes
2DH	Control Ctrl-C and Ctrl-Break
2FH	Select keyboard
30H	Reset extra keyboard variables
31H	Clear keyboard buffer
32H	Select keyclick sound

(Functions 3 and 5 are compatible with the IBM PS/2 BIOS.)

Get key

Entry AH=00H

Exit AH=scan code
AL=character

Description Reads and then removes a keystroke from the keyboard input buffer. (If there is none, the function waits for one.)

The ASCII code is returned in AL. The key scan code is returned in AH. Key codes and scan codes are described in Appendix E.

Get status

Entry AH=01H

Exit ZF=flag
AX=character

Description Checks if there are any characters in the keyboard buffer.

If there is a character, ZF=0 and its ASCII code is returned in AX.

If there is no character, ZF=1.

Note: This function does not remove the character from the buffer.

Get shift status

Entry AH=02H

Exit AL=status

Description Checks the status of the modifier keys and returns the result as separate bits in AL, as follows:

AL	Significance
D7=1	INS mode
D6=1	CAPS LOCK mode
D5=1	NUM LOCK mode
D4=1	SCROLL LOCK mode
D3=1	ALT pressed
D2=1	CTRL pressed
D1=1	left SHIFT pressed
D0=1	right SHIFT pressed

Set key repeat

Entry AH=03H
AL=05H
BL=typematic rate (0..1FH)
BH=delay (0..3)

Exit Returns nothing

Description Sets the delay before keys repeat, and the rate at which they repeat. The rate (in characters per seconds) is set by BL:

BL	Rate	BL	Rate	BL	Rate	BL	Rate
0	30.0	8	15.0	10	7.5	18	3.7
1	26.7	9	13.3	11	6.7	19	3.3
2	24.0	A	12.0	12	6.0	1A	3.0
3	21.8	B	10.9	13	5.5	1B	2.7
4	20.0	C	10.0	14	5.0	1C	2.5
5	18.5	D	9.2	15	4.6	1D	2.3
6	17.1	E	8.6	16	4.3	1E	2.2
7	16.0	F	8.0	17	4.0	1F	2.0

The delay before a key repeats is set by BH:

BH	Delay
0	250mSec
1	500mSec
2	750mSec
3	000mSec
4..FFH	Reserved

Write to buffer

Entry AH=05H
CH=scan code
CL=ASCII code

Exit AL=0 (success) or AL=1 (failed, buffer full).

Description Inserts a 16-bit key token in the keyboard input buffer, exactly as if the user had pressed the corresponding key. Scan codes and ASCII codes are summarised in Appendix E.

Extended get key

Entry AH=10H

Exit AL=ASCII code
AH=scan code

Description This function is exactly the same as function 00H. Scan codes and ASCII codes are summarised in Appendix E.

Extended get status

Entry AH=11H

Exit ZF=flag
AL=ASCII code
AH=scan code

Description Checks if there are any characters in the keyboard buffer. If there is a character, ZF=0 and its ASCII code and scan code are returned in AL and AH. If there is no character, ZF=1.

Note: This function does not remove the character from the buffer.

Extended get shift status

Entry AH=12H

Exit AL=status
AH=extra status

Description Checks the status of the modifier keys and returns the result as separate bits in AL and AH, as follows:

AL	Significance
D7=1	INS mode
D6=1	CAPS LOCK mode
D5=1	NUM LOCK mode
D4=1	SCROLL LOCK mode
D3=1	ALT pressed
D2=1	CTRL pressed
D1=1	left SHIFT pressed
D0=1	right SHIFT pressed

AH	Significance
D7=1	SYSREQ pressed (always 0)
D6=1	CAPS LOCK mode
D5=1	NUM LOCK mode
D4=1	SCROLL LOCK mode
D3=1	right ALT pressed (always 0)
D2=1	right CTRL pressed (always 0)
D1=1	left ALT pressed
D0=1	left CTRL pressed

Set temporary shift [+]

Entry AH=20H
AL=shift status

Exit Returns nothing

Description Sets the shift status as indicated by AL:

D4=1	Scroll lock on
D5=1	Num lock on
D6=1	Caps lock on

The user can override the shift status by pressing the appropriate keys.

Control shift keys [+]

Entry AH=21H
AL=keys to control
BL=shift state required

Exit Returns nothing

Description Disables shift keys and sets them to a specified state. The user cannot override the state of disabled keys.

In both AL and BL, individual bits correspond to different keys, as follows:

Bit	Key
7	INS
6	Caps Lock (🐾C)
5	Num Lock
4	Scroll lock (🐾Esc)
3	ALT
2	CTRL
1	Left ⇧
0	Right ⇧

Bits set in AL specify keys to disable. Bits set in BL specify the state to set those disabled keys in.

Control Ctrl-Alt-Del [+]

Entry AH=22H
AL=control (0=enable, non-0=disable)
BH=7
BL=8
CH=9
CL=10H
DH=11H
DL=12H

Exit AL=0 (success).

Description Disables or re-enables Ctrl-Alt-Del, the key combination that usually reboots an MS-DOS computer.

Use this function to prevent a user breaking out of an application unless they know about the emergency breakout sequence. (But also see function 23H.)

The other registers must be set as shown for the function to operate. This should prevent accidental operation.

Control emergency breakout [+]

Entry
AH=23H
AL=control (0=enable, non-0=disable)
BH=7
BL=8
CH=9
CL=10H
DH=11H
DL=12H

Exit AL=0 (success).

Description If the user presses the X and P keys while turning on, **MP2500** will usually reboot even if it is locked into a program. This is the emergency breakout mechanism.

Use this function to disable emergency breakout, to prevent a user breaking out of an application. You should also use function 22H to prevent use of Ctrl+Alt+Del.

The other registers must be set as shown for the function to operate. This should prevent accidental operation.

Note: If an application locks up with both emergency breakout and Ctrl+Alt+Del disabled, hold down both ⇧ keys and press Ⓘ for at least 5 seconds to produce a hard reset. If this does not work, the unit may be faulty: contact your system supplier for assistance.

Redefine key codes [+]

Entry AH=24H
AL=matrix code of key
BL=new key code

Exit AL=0 (success) or AL<>0 (failed due to out of range parameters).

Description Changes the key code generated by typing the key specified by AL. Each key code is then translated by the INT 9 interrupt handler, into a scan code (which is inserted in the keyboard buffer) or into an immediate action (such as toggle caps lock or turn off).

The matrix codes and key scan codes are summarised in Appendix E.

The standard key matrix is restored on a cold start. You can also restore the default keyboard by using function 25H.

Reset keyboard [+]

Entry AH=25H

Exit AL=0 (success) as cannot fail.

Description Restores the default keyboard mode. This will mainly be used after the keyboard has been redefined by using function 24H.

The default keyboard mode is also restored by a cold start.

Control keyclick [+]

Entry AH=26H
AL=control (0=disable, 1=enable)

Exit AL=0 (success) as cannot fail.

Description Controls production of keyclicks.

Note that keyclicks will also be disabled if sound output is disabled by using INT 15H function 70H, or the MUTE key (S).

The default is for keys to click, which is restored by a cold start.

Get key repeat [+]

Entry AH=29H

Exit BL=typematic rate (0..1FH)
BH=delay (0..3)

Description Gets the delay before keys repeat, and the rate at which they repeat.

The rate (in characters per seconds) is given by BL:

BL	Rate	BL	Rate	BL	Rate	BL	Rate
0	30.0	8	15.0	10	7.5	18	3.7
1	26.7	9	13.3	11	6.7	19	3.3
2	24.0	A	12.0	12	6.0	1A	3.0
3	21.8	B	10.9	13	5.5	1B	2.7
4	20.0	C	10.0	14	5.0	1C	2.5
5	18.5	D	9.2	15	4.6	1D	2.3
6	17.1	E	8.6	16	4.3	1E	2.2
7	16.0	F	8.0	17	4.0	1F	2.0

The delay before a key repeats is set by BH:

BH	Delay
0	250mSec
1	500mSec
2	750mSec
3	000mSec
4..FFH	Reserved

Control key repeat [+]

Entry AH=2AH
AL=0 (disable) or 1 (enable)

Exit Returns nothing

Description Controls the keyboard autorepeat facility.

The default is for keys to repeat. This default is restored by a cold start.

Redefine key scan codes [+]

Entry AH=2BH
AL=0 (unshifted table), 1 (shifted table) or 2 (numlock table)
BH=standard scan code of key (0..128)
BL=new 8 bit token (ASCII code)

Exit Returns nothing

Description Changes the token generated by any standard key. You can redefine as many keys as you want and define the same token for several keys. For example, you could define the left Shift key as Scroll Lock.

Note that the scan codes are used to identify the keys, NOT ASCII codes, so you can redefine any key to any standard function.

Key scan codes are listed in Appendix E.

The standard key tokens are restored on a cold start. You can also restore the default keyboard by using function 25H, or redefine the keys at a lower level by using function 24H.

Redefine PAW key codes [+]

Entry

AH=2CH
AL=matrix code of key
BL=new key code

Exit

AL=0 (success) or AL<>0 (failed due to out of range parameters).

Description

Changes the key code generated by typing the key specified by AL when the ❀ key is held down. Each key code is then translated by the INT 9 interrupt handler, into a scan code (which is inserted in the keyboard buffer) or into an immediate action (such as toggle caps lock or turn off).

The matrix codes used to identify the keys are described under function 24H. Key codes and key scan codes are defined in Appendix E.

The standard key matrix is restored on a cold start. You can also restore the default keyboard by using function 25H.

Control Break keys [+]

Entry

AH=2DH
AL=mask
BX=0708H
CX=0910H
DX=1112H

Exit

AL=0 (success) or AL=FFH (failed)

Description You can use this function to disable the Break keys and so prevent users breaking out of an application. AL is bit-significant, as follows:

AL	Effect
D0=0	Ignore Ctrl-C
D0=1	Normal Ctrl-C action
D1=0	Ignore Ctrl-Break (Ctrl+Esc)
D1=1	Normal Ctrl-Break action

Normal operation of the Break keys is restored by a cold start.

Select keyboard [+]

Entry AH=2FH
AL=0 (default) or 1 (user)

Exit Returns nothing

Description Use this function to switch between the default (developer) and user keyboard modes.

The developer keyboard provides convenient access to the HOT key and other PAW functions, plus Ctrl and Alt codes, which are not appropriate to most users.

The default keyboard is restored on a cold start.

Reset extra keyboard variables [+]

Entry AH=30H

Exit AL=0 (success)

Description Use this function to reset the extra keyboard variables to their defaults, as follows:

Enable Ctrl-Alt-Del
Enable key click
Enable autorepeat
Enable Ctrl-Scroll Lock
Set idle timeout to 5 minutes
Allow emergency breakout
Reset all shifts
Reset all shift locks
Select default (developer) keyboard mode

Clear keyboard buffer [+]

Entry AH=31H

Exit AL=0 (success)

Description Use this function to remove any pending keystrokes from the keyboard buffer.

Select keyclick sound [+]

Entry AH=32H
AL=0 (click) or non-0 (beep)

Exit AL=0 (success)

Description Use this function to change the keyclick sound made when a key is pressed. The beep sound (produced if AL is non-0) is easier to hear in noisy environments.

The default sound, restored on a cold start, is a low-volume click.

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28. INT 17H, Printer Control

The **MP2500** does not have a parallel printer port - all printer access will be directed via the BIOS to COM2.

The **MP2500** supports the standard printer services

Use

Printer output and status.

Entry

AH selects the function required and DX selects the printer number, as shown.

Exit

The AH register returns the printer status. Individual bits have the following significance when set:

Bit	Significance	Returns
7	Printer ready	1
6	Printer acknowledge	1
5	Out of paper	0
4	Printer selected	1
3	I/O error	0
2	Not used	0
1	Not used	0
0	Timeout	0 or 1

Note that the only useful status bit is D0 which returns 1 if a comms error in encountered. (A serial interface cannot return the same amount of status information as a parallel interface.)

All other registers are preserved. The flags are corrupted.

Comments

IBM PC BIOS provides three functions:

00H	Print byte
01H	Initialise printer
02H	Get printer status

The **MP2500** BIOS provides identical functions, but note that only one printer is supported (LPT1). On **MP2500**, this is redirected to COM2 and printing becomes subject to the configuration of COM2: handshaking, speed, timeouts, data bits, etc.

Print byte

Entry AH=00H
AL=byte
DX=printer number (0)

Exit AH=status

Description Sends the byte in AL to the printer port and returns the resulting printer status in AH.

Initialise printer

Entry AH=01H
DX=printer number (0)

Exit AH=status

Description Sends BS (08H) and FF (0CH) to initialise the printer and returns the resulting printer status in AH.

Get printer status

Entry AH=02H
DX=printer number (0)

Exit AH=status

Description Returns the current printer status in AH.

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29. INT 19H, Reboot

Use

Reboot MS-DOS.

Entry

There are no entry parameters.

Exit

There are no exit parameters, as this function does not return.

Comments

This function attempts to reboot MS-DOS from drive C. If this fails, the user is asked to insert a system disk.

This reboot is somewhat quicker than a Ctrl-Alt-Del or power-on reboot, as it bypasses memory checking and reset operations (such as regenerating the equipment list) normally performed during a reboot.

Warning: It is recommended that you do not use the Reboot interrupt if there are TSR (Terminate and Stay Resident) programs installed. Some TSR programs “hook” the Interrupt vectors. Hence using the INT 19H function may result in the unit crashing.

Note: The **MP2500** BIOS includes a boot menu that can be used to change how the system boots (e.g. if the operating system is not present on drive C) and can also be booted from a suitable diskette on a PC. For details, see Chapter 9, *Troubleshooting*, in Part 2.

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30. INT 1AH, Clock Handler [+]

Use

Read or set time, date and alarm.

Entry

AH selects the function required, as follows. Other registers are used for parameters.

Exit

AL, CX and DX are used to return results as described below.

Comments

IBM PC BIOS provides two functions:

00H	Get system clock
01H	Set system clock

The **MP2500** BIOS provides identical functions and four extra IBM PC-AT BIOS compatible functions to use the RTC:

02H	Get RTC time
03H	Set RTC time
04H	Get RTC date
05H	Set RTC date

It also provides four more functions to take advantage of the RTC's alarm functions:

06H	Set RTC alarm
07H	Disable RTC alarm
09H	Get RTC alarm and status
0BH	Set system clock source

If the RTC alarm is set, when the alarm time is reached it is reported via the event handling mechanism. It will also power **MP2500** up if it is powered down when the alarm goes off, providing convenient automatic operation in applications such as data logging.

Note that when the system clock is set, the **MP2500** BIOS also sets the RTC clock, and vice versa.

Get system clock

Entry AH=00H

Exit CX=high part
DX=low part
AL=overrun (0=not past midnight, 1=past midnight)

Description Reads the counter maintained by the BIOS. This indicates the number of 'ticks' since midnight. This count is incremented every 54.95mSec (approximately), by BIOS interrupt 8. If counting past midnight, AL is set to non-zero.

The 'Get RTC date' and 'Get RTC time' functions described below are more useful!

Set system clock

Entry AH=01H
CX=high part
DX=low part

Exit Returns nothing

Description Sets the clock count.

Setting the system clock with this function also sets the RTC clock so that the two do not get out of step.

Get RTC time [+]

Entry AH=02H

Exit CH=hour
CL=min
DH=second
CF=0 (RTC operating) or CF=1 (RTC not operating)

Description If the RTC is operating, CF=0 and CH, CL and DH indicate the time, as BCD digits.

If CF=1, the RTC is not operating correctly because it has become corrupted (eg has had invalid data written to it). To resume normal operation, simply set the correct RTC time and date.

Set RTC time [+]

Entry AH=03H
CH=hour
CL=minute
DH=second

Exit CF=0 (RTC operating) or CF=1 (RTC not operating)

Description Sets the RTC according to the CH, CL and DH (interpreted as BCD digits).

Setting the RTC also sets the system clock, so that the two do not get out of step.

Get RTC date [+]

Entry AH=04H

Exit CH=century
CL=year
DH=month
DL=day
CF=0 (RTC operating) or CF=1 (RTC not operating)

Description If the RTC is operating, CF=0 and CH, CL, DH and DL indicate the date, as BCD digits.

Set RTC date [+]

Entry AH=05H
CH=century
CL=year
DH=month
DL=day

Exit CF=0 (RTC operating) or CF=1 (RTC not operating)

Description Sets the date according to CH, CL, DH and DL (interpreted as BCD digits).

Set RTC alarm [+]

Entry AH=06H
CH=hour
CL=minute
DH=second

Exit CF=0 (RTC operating) or CF=1 (RTC not operating)

Description Sets the RTC alarm to the time specified by CH, CL and DH (interpreted as BCD digits).

When the RTC time reaches the alarm time, an alarm event is generated (if that event is enabled) and **MP2500** will power up (if powered down).

You can disable the alarm by using function 7. Note that if the alarm is disabled, setting the alarm with function 6 re-enables it.

For more details of events, see INT 15H functions 6DH..6FH.

Disable RTC alarm [+]

Entry AH=07H

Exit Preserves all registers

Description This function disables the RTC alarm so it does not operate ie does not power up **MP2500** or cause the alarm event.

The default is for the alarm to be enabled. This default is restored on a cold start.

Get RTC alarm time [+]

Entry AH=09H

Exit
CH=hour
CL=minute
DH=second
DL=0 (not enabled) or DL=1 (enabled)
CF=0 (RTC operating) or CF=1 (RTC not operating)

Description If the RTC is operating, CF=0 and CH, CL and DH indicate the alarm time, as BCD digits, while DL indicates if the alarm is enabled (see function 7).

Set system clock source [+]

Entry

AH=0BH
AL=0 (use DOS tick) non=0 (use RTC)

Exit

Returns nothing

Description

The time can be read from the DOS system clock (tick) or from the RTC; use this function to change the source.

The default, which is restored on a cold start, is to read the time from the RTC, as this is more accurate.

31. Hardware

This chapter describes the **MP2500** hardware in sufficient detail to enable you to write programs to control the hardware directly, if you should need to. It will also help you anticipate or diagnose any problems with using software produced for a standard IBM PC-compatible.

It does not provide sufficient information for you to design internal hardware or modify **MP2500** hardware. For this level of information, contact **HUSKY**.

For pinouts and other interfacing information, see Appendix F.

31.1 Organisation

The **MP2500** hardware has been designed to satisfy two main aims:

1 Provide the convenience of hand-held operation, in a wide variety of arduous working conditions.

2 Provide a hardware environment similar to a desktop computer, so that programs can be conveniently designed and tested on an IBM PC.

The configuration emulated is an IBM PC-AT with CGA graphics adaptor.

The **MP2500** design also includes a number of non-standard devices, namely the LCD, electroluminescent backlight, LCD contrast adjustment and power regulation and monitoring system. There is little or no advantage in direct access to these devices, so their hardware implementation will not be described here; use the BIOS interrupts to access these devices (see Chapter 18.2).

The memory map, hardware interrupts and device emulation details are described in this chapter. For many purposes, the facilities provided by BIOS interrupts will be more convenient (these are summarised in Chapter 18.2 and detailed in Chapters 20 to 30).

31.2 Memory maps

31.2.1 Logical memory map

FFFFFH E0000H	128K (BIOS)
DFFFFH C0000H	128K RAM/ROM (UMB Area)
BFFFFH BC000H	16K (System use: RESERVED)
BBFFFH B8000H	16K RAM (CGA)
B7FFFH A0000H	96K (System use: RESERVED)
9FFFFH 00000H	640K RAM (DOS RAM)

31.2.2 Physical memory map

The physical memory map includes all **MP2500**'s memory-mapped components, including options such as communications and memory expansion modules. Access to these facilities is provided automatically, as and when required, so you do not need information about the physical memory map to use or program **MP2500**.

If your application requires more information about the physical memory map, contact **HUSKY** or your system supplier.

31.2.3 I/O addresses

An IBM PC only uses I/O addresses 0-3FFH, and these are implemented similarly on **MP2500**. **MP2500** also uses other I/O address, but applications MUST NOT use these!

The following tables summarise the I/O operations that can occur on an IBM PC, and indicates those areas which are not fully compatible on **MP2500**. For more details of the individual devices, see section 31.4.

Note: I/O addresses are not fully decoded on an IBM AT, so they are 'reflected' to higher addresses. For example, I/O address 100H could be specified as 100H, 500H, or 900H. This is not the case on **MP2500**.

The **MP2500** DMA controllers, Interrupt Controller, Timer, PPI and RS232 Port hardware are all entirely standard and will not be described further here.

Printer			
Address	**Operation**	**Context**	**Compatible?**
378..37A			NO (ignored)

Colour Graphics Adaptor (CGA)			
Address	**Operation**	**Context**	**Compatible?**
3D0	Read		YES
	Write		YES
3D1	Read	index=14..15	YES
		index=other	NO (ignored)
	Write	index=10..15	YES
		index=other	NO (ignored)
3D2 - as 3D0			
3D3 - as 3D1			
3D4 - as 3D0			
3D5 - as 3D1			
3D6 - as 3D0			
3D7 - as 3D1			
3D8	Read		YES (no effect on IBM)
	Write		YES
3D9	Read		YES (no effect on IBM)
	Write		NO (ignored)
3DA	Read		YES
	Write		YES (no effect on IBM)
3DB	Read		YES (no effect on IBM)
	Write		NO (ignored)
3DC	Read		YES (no effect on IBM)
	Write		NO (ignored)

Diskette Controller			
Address	**Operation**	**Context**	**Compatible?**
3F2			NO (ignored)
3F4			NO (ignored)
3F5			NO (ignored)

31.3 Hardware interrupts

The **MP2500** design includes the normal hardware interrupts, vectors and service routines for an IBM PC. For detailed lists, see section 19.1. For more detailed information, refer to standard texts on IBM PC hardware.

The design also includes a number of interrupts that are not present in an IBM PC, which are mainly concerned with the special requirements of a portable computer. Since **MP2500** is not designed for internal expansion by third parties, the details of these interrupts are irrelevant to most third parties and will not be covered here. For details contact **HUSKY**.

Application programs can trap hardware interrupts (and other interrupts) by changing the vectors to point into their own code. For details, see section 19.1.

CAUTION: **YOU MUST NOT CHANGE VECTOR 02H, which is responsible for servicing NMIs, as NMIs are vital to operation of MP2500. If you change this vector, MP2500 will cease to operate. YOU HAVE BEEN WARNED.**

31.4 Device details

As already mentioned, to be considered IBM PC-compatible, a computer must use the same devices, or emulate them. **MP2500** mainly takes the first option. The main exception is the CGA display system, as the devices used in the IBM PC could not be used to produce a convenient portable design.

This section describes the behaviour of the CGA emulation and indicates where its behaviour differs sufficiently to compromise compatibility. Where a register is described as ‘unimplemented’, any attempt at access will simply be ignored.

Note that compatibility extends even to low level access; you are not limited to access via the BIOS.

For information on the other devices, refer to any standard text on IBM PC-AT hardware.

The 80386EX microprocessor is an enhanced version of the 80386 and is entirely compatible with it, executing all published instructions. The ROM provides a BIOS that is (as far as practicable) IBM PC-compatible, with extensions to use **MP2500**'s special features; the BIOS is described in section 18.2 and Chapters 20 to 30. These components will not be described further here.

For pinouts and other interfacing information, see Appendix G.

31.4.1 CGA and 6845 emulation (display)

The colour graphics adaptor consists of 16 KByte of display memory and seven registers:

Address	**Name**
3D0	6845 index register (also at 3D2, 3D4 and 3D6)
3D1	6845 data register (also at 3D3, 3D5 and 3D7)
3D8	Mode control
3D9	Colour select
3DA	Status
3DB	Clear lightpen latch
3DC	Preset lightpen latch

31.4.1.1 CGA RAM

The CGA RAM is 16 KByte from B8000H to BFFFFH. It is largely standard, and will not be described further here, other than to remind you that on **MP2500**, there is no display 'snow' problem, so programs need not wait for the vertical retrace period before accessing the CGA RAM. (The only non-standard aspect is that the 00H attribute byte (invisible) is not implemented.)

Also note that while the **MP2500** LCD can only display monochrome, all colour and attribute bits are implemented in the CGA RAM, to ensure compatibility.

31.4.1.2 6845 registers

The 6845 CRT controller is the core of the CGA. It has 19 internal registers, which are accessed by writing the internal register number to the **6845 index register**, then reading or writing the **6845 data register**.

The 6845 internal registers are implemented as follows:

Register	Access	Description	Implemented?
0	W	Horizontal total	N
1	W	Horizontal displayed	N
2	W	Horizontal sync	N
3	W	Horizontal sync width	N
4	W	Vertical total	N
5	W	Vertical total adjust	N
6	W	Vertical displayed	N
7	W	Vertical sync position	N
8	W	Interlace mode	N
9	W	Max scan line address	N
10	W	Cursor start	Y
11	W	Cursor end	Y
12	W	Start addr (H)	Y
13	W	End addr (H)	Y
14	RW	Cursor addr (H)	Y
15	RW	Cursor addr (L)	Y
16	R	Lightpen (H)	N
17	R	Lightpen (L)	N

The cursor start and end registers specify the size of the cursor by specifying which lines it starts and ends on. The cursor address registers specify the position of the cursor, as the character number (in the range 0..1999). Both these functions are also provided via INT 10H.

Standard texts advise that the other 6845 registers should not be accessed directly, so the fact that they are not emulated should not cause compatibility problems.

31.4.1.3 Mode control register

The mode control register is write-only. When individual bits are set, they have the following effects:

Bit	Effect	Implemented?
7	Not used	-
6	Not used	-
5	Enable blink	N
4	High resolution mode (640x200)	Y
3	Enable video	N
2	Select B&W	N
1	Select graphics	Y
0	Select 80x25 text	Y

31.4.1.4 Colour select register

The colour select register is not implemented, as **MP2500**'s display is only monochrome.

31.4.1.5 Status register

The status register is a read-only register which returns the adaptor's status by setting individual bits as follows:

Bit	Significance	Implemented?
7	Not used	-
6	Not used	-
5	Not used	-
4	Not used	-
3	Vertical retrace	Y
2	Lightpen switch made	N
1	Lightpen trigger set	N
0	Display enabled	Y

Bits 0 and 3 change each time they are read, returning 1xx1, 0xx1, 1xx0, and then 0xx0 before the pattern repeats. Bit 0 is usually checked by programs to time updates to the CGA RAM (to avoid display 'snow'), but there is no 'snow' problem with the **MP2500** CGA.

31.4.1.6 Lightpen registers

The clear lightpen latch and reset lightpen latch registers are not implemented.

31.4.1.7 Character set

The **MP2500** BIOS provides the full IBM character set in both text and graphics modes. The IBM PC BIOS only provides the full set in text modes; in graphics modes, characters 00H..7FH only are defined.

An application can replace the character definitions for ASCII 80..FFH used in graphics modes by changing the contents of vector 1FH (ie 0007CH..0007FH) to point to its own definitions.

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32. Using Power Handling

This chapter describes the **MP2500** power monitoring, charging, conservation and control systems. These have no equivalent on a desktop computer.

32.1 The facilities

MP2500 has been designed for convenient and efficient operation, and its sophisticated power handling is a very important part of this.

The power-related facilities fall into the following main categories:

- Power-up
- Power-down
- Power monitoring and charging
- Saving power
- Power output

32.1.1 Power-up

Any of the following can cause a power-up:

- Pressing a power-up key
- The RTC alarm going off
- Plugging in the AC adaptor
- Performing a hard reset (⇧⇧ⓘ)

Note that RI (Ring Indicator) is not available on a standard **MP2500**, and cannot be used to power up the unit.

Each cause can be enabled or disabled independently under program control, with the exception of hard reset and the ⏻ key. A program can also determine the reason for power-up, so it can respond appropriately. For example, a program can conserve power by turning off (see the next section) while waiting for a call or the correct time. (See section 32.3 for more information on saving power.)

32.1.1.1 Power-up state

When turned on, **MP2500** will normally resume execution from the state at which it was turned off. This is called 'resume mode', and helps make portable operation extremely convenient.

You can cancel resume mode by using INT 15H, function 64H, and **MP2500** will behave more like a desktop computer, rebooting whenever it is turned on. (Resume mode will also be cancelled if all battery power has been exhausted, including the backup battery.)

The contrast level will normally power up set to a value suitable for normal operating conditions, but you can set the power-up state by using INT 15H function 75H.

32.1.1.2 Power-up key

The power-up key is ⏻. This key cannot be disabled or redefined; if there is any power in the batteries, it will always turn **MP2500** on (although **MP2500** may turn off again immediately, for example if the battery power is below the low power level).

The easiest way to check if ⏻ has caused the power-up is to enable the power key event (using INT 15H function 6EH) before power down, then check the event details on power up, using INT 15H function 6DH.

32.1.1.3 RI

RI is not available on a standard **MP2500**.

32.1.1.4 RTC alarm

The RTC alarm is set by using INT 1AH, function 6. When the RTC time matches the RTC alarm time, it will turn **MP2500** on. You can disable the alarm by using INT 1AH function 07H.

The easiest way to check if the alarm has caused the power up is to enable the alarm event (using INT 15H function 6EH) before power down, then check the event details on power up, using INT 15H function 6DH. (Another, more laborious, way is to read the RTC time and alarm time, using INT 1AH functions 02H and 09H, and compare them.)

32.1.2 Power-down

While turned off, **MP2500** will normally remember the current execution state so that it can restore it when turned on again. This is called 'resume mode'. Resume mode can be disabled by using INT 15H, function 64H, and will be cancelled if all battery power has been exhausted (ie including the backup battery).

MP2500 can power down when:

- The user presses the ⏻ key.
- The keyboard has not been touched for a period exceeding the idle timeout.
- The power-down function (INT 15H, function 68H) is used.
- The battery voltage falls below approximately 3.3V.
- The battery voltage falls below approximately 2.6V to 2.7V (this could be caused by a totally flat battery, power loss, removal of batteries, or an excessive peripheral power load).

With the exception of the last two conditions, all these causes can be enabled, modified, or disabled under program control. This allows programs to ensure that crucial tasks (such as transmitting or saving a file) are completed before power-down.

32.1.2.1 Power-down key

Pressing the ⓘ key will normally turn **MP2500** off, but this can be prevented by using INT 15H function 69H. (This function also prevents power down by the power-down function and idle timeout.)

32.1.2.2 Low power

The **MP2500** power management system monitors the battery voltage. If this falls below approximately 3.3V the **MP2500** will display low power warning messages. If the voltage goes lower the unit will power off.

32.1.2.3 Idle timeout

To conserve power, **MP2500** will normally turn off automatically if left idle (no keyboard input or communications activity) for 5 minutes. When the user is ready to continue, he or she can simply press ⓘ to carry on as if nothing had happened.

You can change the timeout period (or disable it entirely) by using INT 15H function 63H. You can prevent the power down by using INT 15H function 69H (which also prevents power down due to the power-down key or function).

32.1.2.4 Power-down function

The power down function (INT 15H function 68H) can be used to turn off **MP2500**. Use it, for example, to save power when a task is complete or to wait for the RTC alarm or an incoming call to turn it on (see section 32.1.1).

This function can be disabled by INT 15H function 69H.

32.1.2.5 Controlling power-down causes

INT 15H function 69H will prevent power-down due to the idle timeout, power-down key or power-down function. Use it, for example, to make sure that the current task is completed before power-down.

Note that this function cannot prevent power-down due to low power (see section 32.1.2.2) or loss of power.

32.1.2.6 Power loss

If the main batteries are removed or fail (ie the voltage falls below 2.6V-2.7V), or the AC adaptor is turned off whilst batteries are below this level, **MP2500** will immediately turn off regardless of the current activities, and will not turn on again until main power is restored.

When main power is restored, you should find that the memory contents and setup are all intact and that any program which was running when power was lost will continue executing. This is because **MP2500** has a backup battery fitted internally which is charged from the main power source, and is sufficient to maintain RAM contents for a few days.

If main power is lost for longer than a few days, RAM data corruption may occur, but files and programs will remain securely stored indefinitely on the **MP2500's** non-volatile disk.

32.2 Power monitoring and charging

MP2500 provides a single power management mode. Charging can be enabled or disabled by users or by an application.

To prevent users changing the charging setting via the HOT key, use INT 15H function 7BH (to disable the HOT key) or 7CH (to disable the Power option).

Charging is disabled outside the temperature range 0°C to 40°C (32°F to 104°F).

For operating details, such as changing batteries and using the AC adaptor, see Part 2.

32.2.1 Power Management

MP2500 monitors the battery voltage to detect the low power condition. Charging is normally enabled at 160mA for NiCd, and 270 mA for NiMH, but you can disable charging by using INT 15H function 8AH.

The charge rate falls to a trickle automatically after 20 hours have elapsed from the time the charger was plugged in. This ensures that it is safe to leave the unit on charge for long periods unattended.

32.3 Saving power

IMPORTANT
To make the best use of its battery capacity, **MP2500** conserves power in a variety of ways, some obvious, some not so obvious. Most of these mechanisms are entirely automatic and have very little impact on users. However, if you are writing programs, you may need to know about the mechanisms described here.

The power save modes and power down (off) timeout require the unit to become 'idle'. This means that although the processor can be, for example, "waiting for a key", it must not do any significant input / output. The use of any of the following services will override automatic power saving functions:

- Screen services via INT 0H or direct writing to video RAM
- Disk services via INT 13H
- Serial communications via INT 14H or direct access to UARTs
- BIOS extension services via INT 15H
- Time and Date services via INT 1AH
- DOS services via INT 21H
- Access to 8253 sound

If your code is written for a compiler which uses 'standard library routines' you may not even be aware that these services are being used. Generally any ongoing I/O (keyboard, screen and disk) functions will prevent the BIOS from assuming the idle state.

The BIOS can be instructed to allow power save even if some of these functions are in use by using INT 15H function AH=8CH (Get/Set power save entry flag) this is an advanced feature and should only be used with great care.

Please refer to Appendix G for more details on comparison with HUSKY FS handheld computers.

The power-saving aspects fall into the following categories:

- Power modes
- Idle timeouts
- Switchable devices

32.3.1 Power modes

MP2500 can operate in a number of different modes, with different power consumption and capabilities, as follows:

While turned on, **MP2500** is usually in NORMAL mode, but switches to STOP mode whenever it is waiting for keyboard input, to conserve power; when a key is pressed, it switches back to NORMAL mode.

As STOP mode does not respond to interrupts other than RESET and NMI, **MP2500** can miss serial data while waiting for keyboard input, if a communications package which relies on interrupts (such as **HUSKY** communications) is selected.

To reduce this risk but still save power, **MP2500** will use HALT mode instead of STOP mode, once an application has started communications (ie used INT 14H function 1 or 2).

If you think that there still might be problems, you can force **MP2500** to use HALT mode instead of STOP mode, by using INT 15H function 67H. This will make sure that no interrupts are missed, but uses a little more power.

Normally, if an application is using BIOS services, **MP2500** will remain in NORMAL mode even if there is no user input. To allow use of low power modes even while certain services are being used, use INT 15H function 8CH.

32.3.2 Timeouts

MP2500 implements timeouts to conserve power when devices have been idle for a period. These are:

- The keyboard idle timeout. This turns **MP2500** off if the keyboard is not touched for the timeout period and communications is not active (ensure the buffers are empty). To change or disable this timeout, use INT 15H function 63H.

- The backlight option's idle timeout. This turns the backlight off if the keyboard is not touched for the timeout period. To change or disable the timeout, use INT 10H function 65H.

In order for the BIOS time-outs to be used it is necessary for the unit to have been in STOP mode for the period configured for the individual time-outs.

Any application which needs to use the automatic BIOS power save features (time-outs and power save modes) should enable STOP mode during its initialisation by using INT 15H function AH=76h (Chapter 26). This needs to be done since the programmer does not know if STOP mode will be enabled or not when the software is first run. The application default should be to use BX=1, enable unconditional power save. If any inhibitions are required they should be used where, and only where, they are required.

The application should also set up both the idle time-out (automatic power off) and the backlight (option) time-out during initialisation by using INT 15H function AX=6301h, BX=0 (disable) to E10h seconds (Chapter 26) and INT 10H function AX=6501h, BX=0 (disable) to 12Ch seconds (Chapter 21) respectively.

32.3.3 Switchable devices

There are several devices which consume significant power, that you can control from programs. You should keep their use to a minimum:

- The backlight option. Use INT 10H function 65H to set a timeout and INT 10H function 78H to turn it on and off.

- The RS232 interface. This turns on automatically when needed, but programs should turn it off when not needed, using INT 14H function 25H.

32.3.4 Communications and the BIOS Automatic Power Saving Features

Any access to the serial communications port (COM2) will cause the BIOS to use HALT mode rather than STOP mode. Although this will result in lower ongoing power usage it will keep the processor active in order to be prepared to receive incoming interrupts and consequently prevent time-outs from being used correctly.

To re-enable STOP mode after communications is complete the application should follow these steps:

- The handshaking lines (RTS and DTR) should be deactivated and any response from the other end waited for. This should ensure that the other end knows that communications has finished.
- The receive and transmit buffers should be flushed and the communications shut down (UART interrupts disabled, service routines revectored etc. as appropriate). This will prevent further interrupts and other comms activity from causing the BIOS to go back into HALT mode.
- The communications receive buffer should be emptied.
- The RS232 driver should be turned off using INT 14H function AH=25h, AL=0 and DX=1 (Chapter 25). (The driver is automatically reactivated whenever the UART is accessed.)

- Finally, the application should re-enable STOP mode as described in the previous section.

32.3.5 Other situations to look out for

Some applications will have special power requirements not covered above, but generally the same principles will apply for conserving power. That is, when a feature is not actively in use, turn it off.

The situation described below can cause problems if not handled very carefully and may require a lot of work to resolve. If battery life is a critical issue it is essential to analyse the power requirements thoroughly to avoid unnecessary or accidental high current consumption.

32.3.6 Using idle time

Some applications will use idle time, such as that available whilst waiting for user input, to perform background tasks. These tasks may include things like updating an on-screen clock, monitoring or optimising disk usage, checking communications devices, etc. This should be avoided at all costs.

If it is absolutely necessary to perform such tasks they should be done rarely so as to allow the BIOS to spend as much time as possible in STOP mode.

One way to achieve this is to use the RTC alarm to schedule the tasks at regular intervals rather than allowing them to be ongoing during idle time.

32.4 Calculating power usage

32.4.1 Rechargeable batteries

To help you calculate power usage and battery life, here are some typical figures for battery usage. The measurements were carried out at 20°C (68°F), with a battery terminal voltage of 3.6V and no options fitted other than those shown:

MP2500 State (with 2MB RAM)	**Current from battery (typical)**
OFF (Quiescent)**	2mA
ON (Powersave - Stop)	7mA
ON (Powersave - Halt)	85mA
ON (Executing)	120mA

Note: **Add battery self-discharge to this figure (typically 2% to 5% of capacity per day)

For further advice on power calculations, contact **HUSKY** or your supplier.

32.4.2 Alkaline batteries

Note that Alkaline batteries have higher internal resistance, particularly at lower temperatures, so the figures given for rechargeable batteries, above, cannot be used.

As a rough guide, for an **MP2500** unit in an executing state (see the table above), a set of Alkaline batteries can be assumed to have the following usable capacities:

20°C 1500 mAh
0°C 600 mAh
-10°C 200 mAh

32.5 Using the facilities

32.5.1 Setting up

MP2500 allows you to use a range of power sources and provides a wide range of user and programming facilities related to their use. This section provides a few simple guidelines on setting up units to use either Alkaline or rechargeable batteries, which should provide a basis for your procedures. You will probably need to modify your procedures in the light of experience.

Switching units from one battery type to the other requires a little more care. This is described in Part 2, and should normally only be undertaken by reliable personnel, typically within your technical support department.

32.5.1.1 Using alkaline batteries

If the users are competent, familiarise them with the instructions in Part 2 on changing batteries and using the HOT key, and provide them with spare batteries.

If the unit will be used by non-technical operators and exclusively with alkaline batteries, set it up as follows:

- Use the HOT key power option (see Chapter 11) to set Battery Charging Support to Disabled

- Install the application and issue the units, fitted with alkaline batteries (plus spare alkalines). **Do not provide AC adaptors, or rechargeable batteries.**

- Tell users about the low power warnings, so they will know when to change the batteries.

If users do not need to change batteries while away from home base, you need not provide the spare batteries; instead, the user's technical support department could provide all battery changing facilities.

32.5.1.2 Using NiCd or NiMH batteries

If the users are competent, familiarise them with the instructions in Part 2 on recharging batteries and using the HOT key, and provide them with AC adaptors.

If the units will be used by non-technical operators exclusively with NiCd or NiMH batteries, set each one up as follows:

- Fit the rechargeable batteries and connect the AC Adaptor.
- Use the UTIL **`Non-volatile configuration`** option to select the battery charging type - **`Nicad`** or **`NiMH`**. The selection you make will be stored in the unit's non-volatile memory.
- Use the HOT key power option (see Part 2) to set Battery Charging Support to Enabled:
- Install the application(s) on each unit.
- You may wish to fully charge each unit immediately before issuing it by leaving it to charge for 15 hours.
- Give out the units fitted with NiCd or NiMH batteries and provide AC adaptors. **Do not provide Alkaline batteries**. Ensure the correct battery type is provided, do not mix NiCd and NiMH batteries.
- Tell users about low power warnings, so they will know when to recharge. Make sure they know how to recharge and do so regularly. **Tell users not to remove the battery cap**.

If users do not need to recharge batteries while away from base, you need not provide the AC adaptor; instead, the user's technical support department could provide all battery charging facilities for them. For example, they could recharge all units overnight, at the end of each day.

32.5.2 Charging NiCd or NiMH batteries

By default, users can authorise charging by using the power option of the HOT key, but you should disable this (INT 15H functions 7CH and 7EH) if you think there is any likelihood that they will fit Alkaline batteries and then attempt to charge them. REMEMBER, ATTEMPTING TO RECHARGE ALKALINE BATTERIES IS HAZARDOUS AND CAN DAMAGE THE **MP2500**!

If you do disable the HOT key power option, you will need to provide charging facilities to **someone**. For example, a supervisor might perform all recharging, in which case you could write a simple utility which grants temporary access to the HOT key, but not give copies to users.

Another method would be to build recharging facilities into each application or into a separate utility, but protect them by a password, which you only provide to responsible individuals.

32.6 Default charging parameter settings

Note: On a new **MP2500**, the initial default values will be configured as follows:

Description	**Default**
Battery Charging Support	Disabled
Battery Type	NiCd

If the unit is reset after the RAM backup battery has run flat, the Battery Type will still be remembered (as it is stored in flash memory), but the Battery Charging Support setting will default to **Disabled**.

Appendix A: Specification

WPI HUSKY COMPUTERS LTD. reserves the right to alter the specification or conditions of any product or service without prior notice.

A.1 Physical

Construction	Impact-resistant plastic moulding.
Finish	Durable and chemical-resistant textured surface.
Size	242mm x 132mm x 44mm (9.5 ins x 5.2 ins x 1.7 ins) maximum, excluding feet and connectors. 73mm (2.9 ins) at handgrip.
Weight	Approximately 680 grams (24oz) including alkaline batteries, or 700 grams (25oz) including rechargeable batteries.
Sealing	Waterproof against accidental immersion. (IP65.)
Straps	Backstrap. Neck strap option.

A.2 Fascia

Screen	240 x 64 pixel full graphics liquid crystal display with keyboard controlled contrast adjustment. Display area: 88.7mm x 29.4mm (3.5 ins x 1.2 ins) nominal.
Backlight (optional)	Electroluminescent panel, with keyboard and program control.
Keyboard	The keyboard has 55 programmable keys plus the ⏻ (power) key, with separate numeric keypad. One-handed operation for numeric data entry. Waterproof, sealed. Custom keyboard overlays and layouts available. Consult **HUSKY** or your supplier.

Sealed flat membrane keyboard option available.

Fluorescent "glow in the dark" overlay option available for membrane keyboard.

A.3 Programming

Operating system	MS-DOS 6.22.
Operating system interface	Assembly language access to standard and extended functions, via BIOS/MS-DOS.
Storage	Operating system, programs and data stored in non-volatile CompactFlash Disk.
Screen handling	ANSI/IBM PC interface, emulating IBM CGA text and graphics modes. The LCD screen forms a window on a larger (CGA-compatible) virtual screen. The window moves automatically and can also be moved by using the keyboard or under program control.
Keyboard	All keys other than ⏻ (power key) reprogrammable in software.
Sound	IBM PC compatible, with mute function. Note: The sounder volume is optimized for operation at 2kHz.

A.4 Communications

Port 1	COM2 only. Standard modem interface, via a 9 pin 'D' type connector.
Configuration	The COM port provides the usual IBM PC port facilities, but additional facilities may be selected under software control, including:
Baud rate	110 to 19,200 Baud asynchronous. Note: 38,400 Baud not recommended for **MP2500.**

Buffering	Independent 256 byte buffers for Tx and Rx, interrupt-driven for efficiency.
Protocols	XON/XOFF protocol provided as standard for flow control.
Handshaking	RTS, CTS, DTR, DSR, DCD, all selectable by software.

A.5 Screen

Text modes	In text modes, 25 x 40 or 25 x 80 characters on the virtual screen, default 8 x 40 visible at a time in the LCD window (maximum 10 x 60). Variable text size, to enhance readability.
Graphics resolution	320 x 200 or 640 x 200 on the virtual screen. 240 x 64 pixels visible at a time in the LCD window.
Graphics text	In graphics modes, six different character sizes provide up to 10 x 60 on the LCD screen.
Graphics commands	Software support for drawing lines, boxes, ellipses, circles and points.
LCD facilities	Automatic scrolling over virtual screen, with keyboard and program control. Split screen facility. Screen lookup facility.

A.6 Memory

RAM	2 MByte of low power DRAM.
RAM retention	Battery support with fixed internal backup.
Flash EPROM	On-board: 128 KByte minimum, containing the **HUSKY** BIOS.

Disk	Non-volatile 4 MByte CompactFlash Disk.

A.7 Clock/calendar

Type	Software accessible time, day, date.
Accuracy	Typically +/- 2 seconds per day, but adversely affected by extremes of temperature.
Integrity	Non-volatile, battery backed.

A.8 Microprocessor

Type	32 bit Intel 386EX.
Clock speed	8 MHz.

A.9 Batteries

Main batteries	Three A-size Nickel Cadmium (NiCd) rechargeable cells, three A-Size Nickel Metal Hydride (NiMH) rechargeable cells, or three AA-size Alkaline cells. **HUSKY** supplies the NiCd or NiMH cells as a battery pack, with the three cells assembled into a single battery stick. The NiCd stick is colour coded with **black** sleeving. The NiMH stick is colour coded with **green** sleeving.
CAUTION:	**Do not fit Lithium batteries under any circumstances.**
Operating life	Operating life depends on the **MP2500** configuration, the application, and usage. Alkaline batteries are only recommended for light duty applications, and are not suited to low temperature applications.

Power monitoring	Standard Power Management provides automatic power conservation and shut off facilities.
Recharging	NiCd and NiMH batteries can be recharged in situ using the supplied AC adaptor. Charging is under software control.
Data retention	Built-in trickle-charged battery guarantees data integrity for 12 to 18 hours at 20°C (68°F) when all other power is removed, under normal operating conditions. Reduced at temperature extremes.
Important Note:	Data written to the internal disk is retained "indefinitely", so data should **always** be written to disk before storing the **MP2500** for any length of time.

A.10 Charger Input

Voltage requirement	7.0 to 9.7 Volts **Note: MP2500** can tolerate up to 18 Volts without damage, but will not operate above 9.7 Volts.

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Appendix B: Operating Environment

B.1 Operating Temperature

The recommended operating temperature is from -30°C to +60°C (-22°F to +140°F).

Below -30°C (-22°F) the LCD screen may become damaged. Prolonged exposure to temperatures above 60°C (+140°F) may damage the unit. Do not exceed +70° (+158°F).

Recharging should not be performed outside the range 0°C to 40°C (32°F to 104°F nominal), so outside this range charging is disabled by the BIOS. Battery capacity and RTC (clock) accuracy are adversely affected by operation or storage at the temperature extremes.

B.2 Humidity

The **MP2500** is designed to operate in conditions of up to 90% relative humidity. It has an internal desiccator and a visual indicator shows any water ingress (by changing from blue to pink).

B.3 Waterproofing and Dustproofing

The **MP2500** is designed to resist the ingress of water and dust, to standard IP65 (BS 5490). Factory pressure testing assures that leaks do not occur. Sealing characteristics can be impaired by non **HUSKY** approved maintenance or modifications, or by impact damage. The commonest cause of failure is a loose battery cap.

The **MP2500** will withstand exposure to rain without ingress of water.

If water is trapped in the keyboard area it may lead to progressive keyboard failure, exhibited by "over sensitive" or "latched on" keys. To avoid this, drain the unit by storing it vertically in a warm place. **MP2500** should recover when dry. Forced drying is not recommended.

If fine dust or liquids (such as coffee) congeal in the keyboard and prove difficult to remove, make sure that the battery cap is secure and then rinse the unit carefully in warm running water.

For very wet, dusty, or dirty applications, the sealed flat membrane keyboard option is recommended.

If water is trapped in the connector, blow it out when convenient.

B.4 Storage Conditions

A possible risk with long term storage is battery leakage, which can cause very serious damage to the **MP2500**. Use only **HUSKY** NiCd or NiMH sticks, or the highest quality Alkaline batteries. Ensure that Alkaline batteries are brand new when fitted and NiCd/NiMH batteries are fully charged.

For longer-term storage or shipping, it is recommended that batteries are NOT fitted. For normal storage or periods of non-use, you may leave batteries fitted. The permissible storage temperature range is -30°C to +70°C (-22°F to +158°F) but avoid prolonged periods above +60°C (+140°F). As battery life is much shorter at higher temperatures we recommend storage at less than 35°C (+95°F).

Under these storage conditions we recommend alkaline batteries are replaced every 4 to 6 weeks.

Data retention is only guaranteed in the range of -30°C to +60°C (-22°F to +140°F), but we recommend that you store all files on non-volatile disk before storage.

If stored with NiCd or NiMH cells fitted, discharge and fully recharge them every four weeks (assuming storage at between +10°C and +30°C (+50°F and +86°F)) and before issuing the unit.

Battery capacity and RTC (clock) accuracy are adversely affected by operation or storage at the temperature extremes.

B.5 Electromagnetic Compatibility

The **MP2500** is designed to meet EN55022, BS6527, VfG243, FCC Rules Part 15, and European Community EMC directive 89/336/EEC.

B.6 Resistance to Shock, Vibration and Impact

The **MP2500** is designed to withstand the rigours of normal use, including such demanding applications as field service and data collection in the field.

The **MP2500** is designed to withstand shock and accidental drops from up to 1.2 m (48 inches) onto a hard surface and random vibration from transportation or use in wheeled or tracked vehicles. It is recommended that repeated abuse be avoided as far as practical.

B.7 Resistance to Pressure and Elevation

The **MP2500** is designed to resist low pressure levels that would result from transportation in an unpressurised aircraft (equivalent to 15,000 ft; 4,500 m) or operating at high elevations (10,000 ft; 3,000 m).

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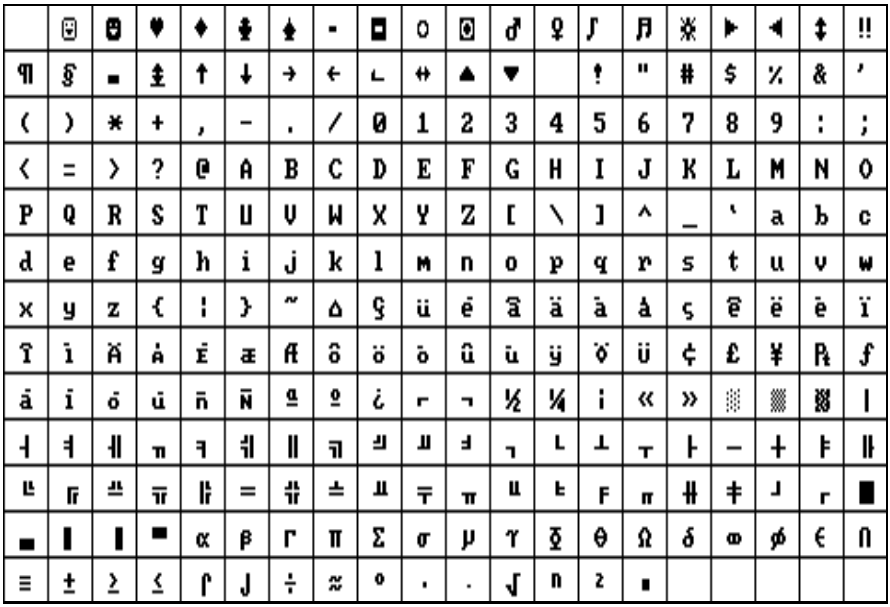
Appendix C: Character Set

The **MP2500** provides five different character sets, based on grids of 8x6, 8x8, 9x7, 11x8 and 6x4. Each set is based on the extended IBM PC character set and includes all 256 characters (ASCII codes 0 to 255):



Note that ASCII 0 (NUL), 32 (space) and 255 are all blank.

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Appendix D: Hexadecimal to Decimal Conversion

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
0	00	32	20	64	40	96	60	128	80	160	A0	192	C0	224	E0
1	01	33	21	65	41	97	61	129	81	161	A1	193	C1	225	E1
2	02	34	22	66	42	98	62	130	82	162	A2	194	C2	226	E2
3	03	35	23	67	43	99	63	131	83	163	A3	195	C3	227	E3
4	04	36	24	68	44	100	64	132	84	164	A4	196	C4	228	E4
5	05	37	25	69	45	101	65	133	85	165	A5	197	C5	229	E5
6	06	38	26	70	46	102	66	134	86	166	A6	198	C6	230	E6
7	07	39	27	71	47	103	67	135	87	167	A7	199	C7	231	E7
8	08	40	28	72	48	104	68	136	88	168	A8	200	C8	232	E8
9	09	41	29	73	49	105	69	137	89	169	A9	201	C9	233	E9
10	0A	42	2A	74	4A	106	6A	138	8A	170	AA	202	CA	234	EA
11	0B	43	2B	75	4B	107	6B	139	8B	171	AB	203	CB	235	EB
12	0C	44	2C	76	4C	108	6C	140	8C	172	AC	204	CC	236	EC
13	0D	45	2D	77	4D	109	6D	141	8D	173	AD	205	CD	237	ED
14	0E	46	2E	78	4E	110	6E	142	8E	174	AE	206	CE	238	EE
15	0F	47	2F	79	4F	111	6F	143	8F	175	AF	207	CF	239	EF
16	10	48	30	80	50	112	70	144	90	176	B0	208	D0	240	F0
17	11	49	31	81	51	113	71	145	91	177	B1	209	D1	241	F1
18	12	50	32	82	52	114	72	146	92	178	B2	210	D2	242	F2
19	13	51	33	83	53	115	73	147	93	179	B3	211	D3	243	F3
20	14	52	34	84	54	116	74	148	94	180	B4	212	D4	244	F4
21	15	53	35	85	55	117	75	149	95	181	B5	213	D5	245	F5
22	16	54	36	86	56	118	76	150	96	182	B6	214	D6	246	F6
23	17	55	37	87	57	119	77	151	97	183	B7	215	D7	247	F7
24	18	56	38	88	58	120	78	152	98	184	B8	216	D8	248	F8
25	19	57	39	89	59	121	79	153	99	185	B9	217	D9	249	F9
26	1A	58	3A	90	5A	122	7A	154	9A	186	BA	218	DA	250	FA
27	1B	59	3B	91	5B	123	7B	155	9B	187	BB	219	DB	251	FB
28	1C	60	3C	92	5C	124	7C	156	9C	188	BC	220	DC	252	FC
29	1D	61	3D	93	5D	125	7D	157	9D	189	BD	221	DD	253	FD
30	1E	62	3E	94	5E	126	7E	158	9E	190	BE	222	DE	254	FE
31	1F	63	3F	95	5F	127	7F	159	9F	191	BF	223	DF	255	FF

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Appendix E: Keyboards

The keyboards shown in this appendix refer to the standard **MP2500** English layout - typically used for UK, USA, and by many other countries. Note: **HUSKY** also supplies Scandanavian character-set keyboards, and some special layouts. If you have a keyboard other than the English layout, please contact you system supplier, or **WPI HUSKY TECHNOLOGY LTD** for further information.

E.1 Keyboard layouts

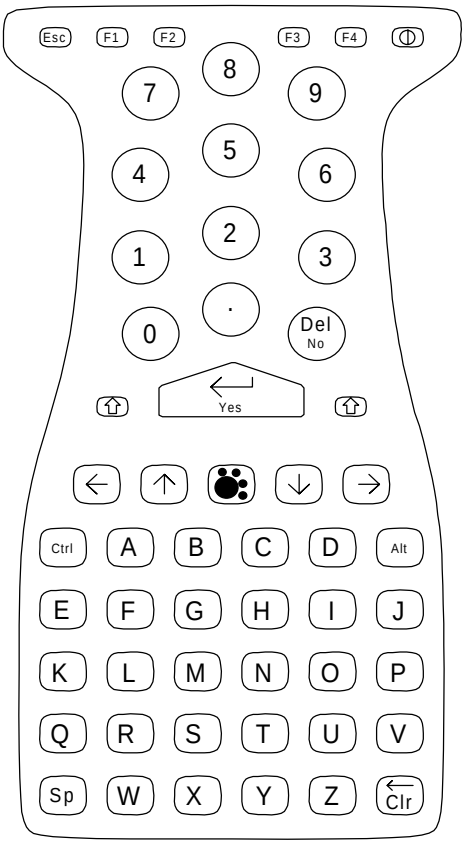
The **default (developer) mode** keyboard functions like this:

This is the keyboard mode provided when the **MP2500** is first unpacked, or after a cold start.

It is mainly intended for initial setting up, program testing, and maintenance work, as it provides easy access to the [paw], [Ctrl] and [Alt] keys.

Note that the location of these three keys is indicated by the legends on the keyboard overlay, rather than on the keys.

[Note also that on the Scandinavian keyboard, the alpha key legends are differently arranged (to accommodate the extra alpha keys), and the [Ctrl] and [Alt] keys are repositioned to be in the positions shown as [X] and [Y] in this diagram.]



The **standard user mode** keyboard functions like this:

This keyboard mode can be selected by using an extended BIOS function or pressing both ⇧ keys plus the key immediately above the ⇦ key (shown as ⊙ in the diagram opposite).

It is mainly intended for users, as it provides easy access to the Backlight, PgUp and PgDn keys (but not 🐾, Alt and Ctrl).

Note this is the keyboard mode indicated by the legends on the key tops.

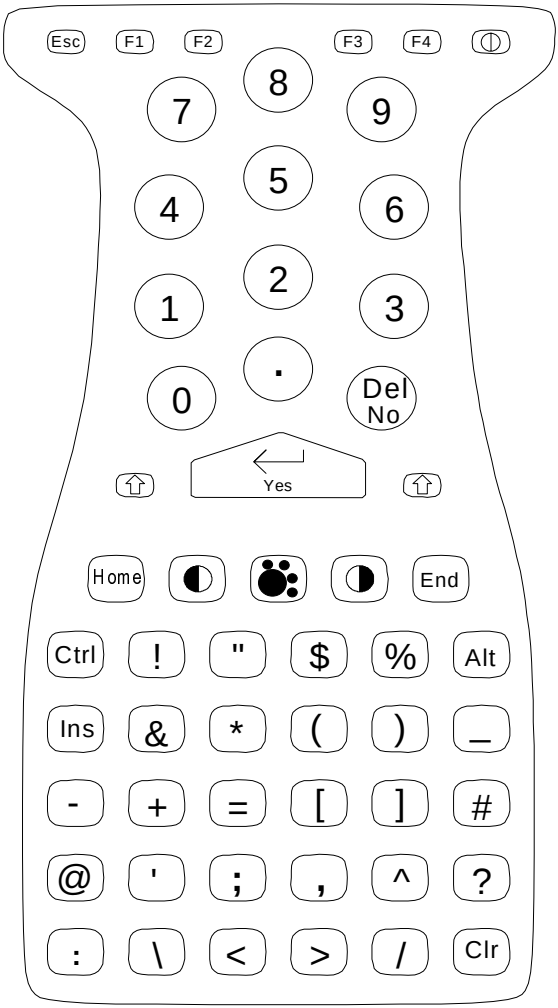
[Note also that on the Scandinavian keyboard layout, the alpha key legends are differently arranged.]

This is the **developer's mode keyboard** when used with either **Shift** (⇧) key, with the numeric keypad shift function disabled:

The user keyboard differs in the same three keys as described above.

Applications may however redefine any of the keys by using extended BIOS functions (see Part 3).

[Note also that on the Scandinavian keyboard layout, the alpha key legends are differently arranged.]



E.2 Key matrix codes

The **MP2500** keyboard can be reprogrammed at a low level, by changing the key code assigned to each physical key, using INT 16H function 24H, so you can reprogram any key on the keyboard (other than ⓘ) to act as any other key. The key matrix codes, which are used to identify the physical keys, are as follows:

Code	Key	Code	Key	Code	Key	Code	Key
0		24		48	5	72	F3
1		25	↓	49	I	73	0
2		26	B	50	O	74	
3		27	G	51	U	75	
4	PgUp*	28	M	52	Z	76	
5	E	29	S	53		77	
6	K	30	X	54		78	7
7	Q	31		55	Del	79	4
8	Sp	32		56	9	80	
9	left ⇧	33		57	2	81	F1
10	right ⇧	34		58	→	82	
11		35	☼*	59	↑	83	Esc
12		36	←	60	J	84	1
13	←	37	C	61	P	85	
14	PgDn*	38	H	62	V	86	
15	A	39	N	63	⇐ Clr	87	
16	F	40	T	64		88	ⓘ
17	L	41	Y	65		89	
18	R	42		66	F4		
19	W	43		67	8		
20		44		68	3		
21		45	6	69			
22		46	⊙	70	F2		
23		47	D	71			

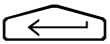
Note: Keys marked with * have other functions in the developer's layout.

E.3 Scan codes

The **MP2500** keyboard provides entirely standard key codes to the key scan routine (INT 9 service routine), which translates them into scan codes. The ASCII part of all scan codes is entirely PC-compatible, but the key token part for some of the shifted key symbols is non-standard.

Note that the special **MP2500** keys (ⓘ and ❀) and key sequences that are used to control the **MP2500** (such as the HOT key and LCD flip keys) generate extra key codes that are not generated by keys on an IBM keyboard.

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
01	Esc	011B	ignore	011B	011B	-
02	1	0231	7800	ignore	0221	-
03	2	0332	7900	0300	0340	-
04	3	0433	7A00	ignore	0423	-
05	4	0534	7B00	ignore	0524	-
06	5	0635	7C00	ignore	0625	-
07	6	0736	7D00	071E	075E	-
08	7	0837	7E00	ignore	0826	-
09	8	0938	7F00	ignore	092A	-
0A	9	0A39	8000	ignore	0A28	-
0B	0	0B30	8100	ignore	0B29	-
0C	-	0C2D	8200	0C1F	0C5F	-
0D	=	0D3D	8300	ignore	0D2B	-
0E	Clr	0E08	ignore	0E7F	0E08	-
0F	Tab	0F09	ignore	ignore	0F00	-

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
10	Q	1071	1000	1011	1051	-
11	W	1177	1100	1117	1157	-
12	E	1265	1200	1205	1245	-
13	R	1372	1300	1312	1352	-
14	T	1474	1400	1414	1454	-
15	Y	1579	1500	1519	1559	-
16	U	1675	1600	1615	1655	-
17	I	1769	1700	1709	1749	-
18	O	186F	1800	180F	184F	-
19	P	1970	1900	1910	1950	-
1A	[	1A5B	ignore	1A1B	1A7B	-
1B	]	1B5D	ignore	1B1D	1B7D	-
1C		1C0D	ignore	1C0A	1C0D	-
1D	Ctrl	ignore	ignore	-	ignore	-
1E	A	1E61	1E00	1E01	1E41	-
1F	S	1F73	1F00	1F13	1F53	-
20	D	2064	2000	2004	2044	-
21	F	2166	2100	2106	2146	-
22	G	2267	2200	2207	2247	-
23	H	2368	2300	2308	2348	-
24	J	246A	2400	240A	244A	-
25	K	256B	2500	250B	254B	-
26	L	266C	2600	260C	264C	-
27	;	273B	ignore	ignore	273A	-

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
28	'	2827	ignore	ignore	2822	-
29	#	2960	ignore	ignore	297E	-
2A	Left ⇧ (shift)	ignore	ignore	ignore	-	-
2B	\	2B5C	ignore	2B1C	2B7C	-
2C	Z	2C7A	2C00	2C1A	2C5A	-
2D	X	2D78	2D00	2D18	2D58	-
2E	C	2E63	2E00	2E03	2E43	-
2F	V	2F76	2F00	2F16	2F56	-
30	B	3062	3000	3002	3042	-
31	N	316E	3100	310E	314E	-
32	M	326D	3200	320D	324D	-
33	,	332C	ignore	ignore	333C	-
34	.	342E	ignore	ignore	343E	-
35	/	352F	ignore	ignore	353F	-
36	Right ⇧ (shift)	ignore	ignore	ignore	-	-
37	Print Screen (print screen)	372A	ignore	7200	Print	-
38	Alt	ignore	ignore	-	ignore	-
39	Sp	3920	3920	3920	3920	-
3A	Caps Lock (CapsLock)	ignore	ignore	ignore	ignore	-
3B	F1	3B00	6800	5E00	5400	-
3C	F2	3C00	6900	5F00	5500	-
3D	F3	3D00	6A00	6000	5600	-
3E	F4	3E00	6B00	6100	5700	-
3F	F5	3F00	6C00	6200	5800	-

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
40	F6	4000	6D00	6300	5900	-
41	F7	4100	6E00	6400	5A00	-
42	F8	4200	6F00	6500	5B00	-
43	F9	4300	7000	6600	5C00	-
44	F10	4400	7100	6700	5D00	-
45	Num Lock	ignore	ignore	Pause	ignore	-
46	Scroll Lock	ignore	ignore	(Break)	ignore	-
47	Keypad 7/Home (Home)	4700	ignore	7700	-	4737
48	Keypad 8	4800	ignore	ignore	-	4838
49	Keypad 9/PgDn	4900	ignore	8400	-	4939
4A	Keypad -	4A2D	ignore	ignore	-	4A2D
4B	Keypad 4	4B00	ignore	7300	-	4B34
4C	Keypad 5	ignore	ignore	ignore	-	4C35
4D	Keypad 6	4D00	ignore	7400	-	4D36
4E	Keypad +	4E2B	ignore	ignore	-	4E2B
4F	Keypad 1/End (End)	4F00	ignore	7500	-	4F31
50	Keypad 2	5000	ignore	ignore	-	5032
51	Keypad 3/PgUp	5100	ignore	7600	-	5133
52	Keypad 0/Insert (insert)	5200	ignore	ignore	-	5230
53	Keypad ./Delete (delete)	5300	ignore	ignore	-	532E

Key Code	Key	Normal token	Alt token	Ctrl token	Shift token	Num lock
54 ..7F	Undefined	ignore	ignore	ignore	ignore	ignore

Key tokens described as 'ignore' are actually returned with bit 7 set, which causes them to be ignored.

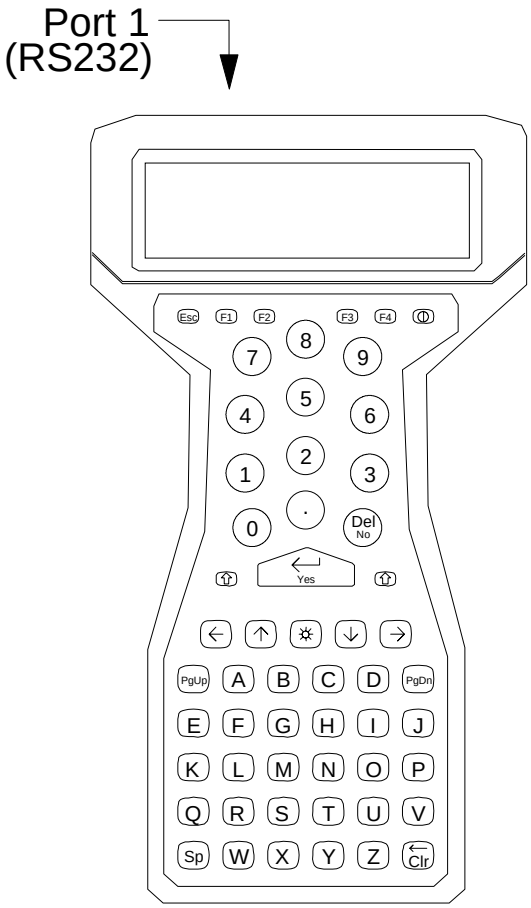
The following key codes are non-standard. They can be used in INT 16H function 24H, to reprogram the extra **MP2500** keys and reprogram keys to perform non-standard actions:

Key Code	Key Action
B1	F10 (🐾0)
B2	F9 (🐾9)
B3	F8 (🐾8)
B4	F7 (🐾7)
B5	F6 (🐾6)
B6	F5 (🐾5)
B7	F4 (🐾4)
B8	F3 (🐾3)
B9	F2 (🐾2)
BA	F1 (🐾1)
BB	Reserved
BC	Reserved
BD	]
BE	[
BF	Scroll lock (🐾Esc)
C0	Print screen (⇧🐾P)
C1 ..E6	Undefined
E7	Reserved
E8	Increase contrast with wraparound (see below)**
E9	Reserved
EA	Reserved

Key Code	Key Action
EB	Reserved
EC	Reserved
ED	Momentary SHIFT (shift next key)
EE	HOT key (🐾H)
EF	Toggle sound (🐾S)
F0	Reserved
F1	Reserved
F2	Flip window (🐾F)
F3	Shift window right (🐾→)
F4	Shift window left (🐾←)
F5	Shift window down (🐾↓)
F6	Shift window up (🐾↑)
F7	Reserved
F8	Toggle backlight option (🐾L)
F9	Reserved
FA	Reserved
FB	Decrease contrast (🐾X)
FC	Increase contrast (🐾E)
FD	ⓘ
FE	🐾
FF	No action ie ignore key

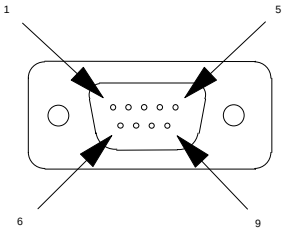
**When the contrast reaches maximum, this key will start again from minimum contrast.

Appendix F: Interfacing



F.1 9-way D type (Port 1)

The 9-way D type connector provides access to the main serial port, Port 1 (COM2). The pinouts are as follows:



Pin	Description	Pin	Description
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Charger in
5	Signal Ground		NB. RI not available

The electrical specification of this interface is normally in accordance with EIA specification RS232C.

OUTPUTS	RS232 levels
Logic 0:	> +5.0V
Logic 1:	< -5.0V

Absolute maximum voltage inputs +/- 25V.

INPUTS	RS232
Logic 0:	+2.4V maximum
Logic 1:	+0.8V minimum

Input pins present an impedance of between 3 and 7 Kohm.

Appendix G: MP2500, FS3 and FS/2

This appendix summarises the main differences between the **HUSKY MP2500** and the **HUSKY** FS range, for users who are adapting **FS** applications to run on the **MP2500**.

G.1 Hardware and user differences

Batteries

MP2500 and **FS3** can support both NiCd and NiMH rechargeable batteries; **FS/2** only supports NiCds. Due to higher peak power requirements, **MP2500** and **FS3** are less suited to use with Alkaline batteries (especially at low temperatures).

MP2500 and **FS3** are shipped without any main batteries installed, so the initial configuration procedures for **FS/2**, **FS3** and **MP2500** are different and it is important that they are followed (see the **MP2500** and **FS3** User Leaflets).

Caution: Do not use **MP2500** or **FS3** rechargeable batteries in an **FS/2**. While this is not hazardous, the **FS/2** may malfunction.

External input voltage (charger input)

FS/2	8V to 28V (absolute maximum)
MP2500 and FS3	7V to 9.7V (operational) >9.7V to 18.0V - safe, but the FS3 will not operate 18.0V absolute maximum

Note: FS/2 and **MP2500/FS3** vehicle chargers are NOT interchangeable.

Power and charging times

The **FS/2** and **FS3** charging currents are significantly different, which affects charging times as shown in the following table. The times shown are for ***guidance only***, and are for fully recharging a discharged battery:

Model	Battery		APM		FPM		SPM	
	Type	Capacity mAh (nominal)	Charge mA (hrs)	Maint mA	Charge mA (hrs)	Maint mA	Charge mA (hrs)	Maint mA
MP2500 BIOS 1.01 or earlier	NiCd	1600	N/A		N/A		160 (15h)	55
MP2500 BIOS 1.01 or earlier	NiMH	2700	N/A		N/A		270 (15h)	70
MP2500 BIOS 1.02 or later	NiCd	1600	N/A		N/A		240 (10h) Note 1	55
MP2500 BIOS 1.02 or later	NiMH	2500	N/A		N/A		270 (14h) Note 1	0
FS3	NiCd	1600	340 (7h)	55* Note 2	340 (7h)	55* Note 2	160 (15h)	55* Note 2
FS3 Prior to October 1998	NiMH	2100	340 (9h)	70* Note 2	340 (9h)	70* Note 2	210 (15h)	70* Note 2
FS3 From October 1998	NiMH	2700	340 (12h)	70* Note 2	340 (12h)	70* Note 2	210 (19h)	70* Note 2
FS3 BIOS 1.08 or later	NiMH	2500	340 (12h)	0 Note 3	340 (12h)	0 Note 3	270 (15h) Note 3	0 Note 3
FS/2	NiCd	1400	340 (6h)	70	340 (6h)	70	120 (17h)	70

Note 1: From BIOS 1.02 the charging rates on **MP2500** were increased as shown. Also “charging complete” messages were added as follows – after 8.5 hours for NiCd and 12 hours for NiMH batteries. (The charge times in the table are maximums. The charge current is reduce to maintenance after these times, not the “charging complete” times.)

Note 2: Figures marked * apply to **FS3** BIOS version 1.07x.

Note 3: SPM charging rate of 270mA for NiMH applies to **FS3** BIOS version 1.08 or higher, and the NiMH maintenance charge is zero.

The charging temperature range is fixed on the **MP2500** and **FS3** at 0°C to 40°C (32°F to 104°F nominal); on the **FS/2** the range is software-configurable.

Rapid Discharge

The **MP2500** does not support rapid discharge, whereas the **FS/2** and **FS3** do.

Power save modes

MP2500 and **FS3** have two power save modes, like **FS/2**:

- STOP mode: lowest consumption, no comms allowed.
- HALT mode: some power saving, comms allowed.

Since **MP2500** and **FS3** have a 386 microprocessor and run at higher execution speeds, the execution current consumption is higher.

On **MP2500** and **FS3**, software applications should be written to take advantage of the STOP mode where the computer is switched on, but microprocessor activity is at a minimum.

HALT mode uses approximately 85mA, which is less than full EXECUTION, so it is important to select STOP mode as soon as possible after comms have ceased. Since **MP2500** and **FS3** do not use comms emulation by default, they maintain a comms activity flag instead.

Typical Current Consumption					
	Bus Clock speed	**Off**	**Stop**	**Halt**	**Executing**
MP2500	8MHz	2mA	7mA	85mA	120mA
FS/2	8MHz	0.1mA	10mA	65mA	105mA
FS3	25MHz	2mA	7mA	85mA	300mA
FS3	16MHz	2mA	7mA	85mA	210mA

Execution speed

MP2500 uses a 386EX processor (like **FS3**), but running at 8MHz. The execution speed is slower than **FS3**, but slightly faster than **FS/2** (which also runs at 8MHz). However, the display update processing time on **MP2500** is 50% longer than on **FS/2**, so overall program execution may be slower than on **FS/2**.

RTC (real time clock)

FS/2 supports 1/10th second reading from the RTC; **MP2500** and **FS3** do not.

Formatting the Fixed Disk

The **MP2500** and **FS3** UTIL utility cannot format drive C (a CompactFlash drive), since this would erase the entire operating system. To format drive C, you must use a utility diskette, which also provides support for re-instating the operating system.

The **FS/2** UTIL utility can format drive C since the operating system is held separately.

PC Card support

The standard **MP2500** does not support PC Cards.

FS3 supports a single internal PC Card. **FS/2** does not support PC Cards.

Interrupt-driven polled comms

FS/2 automatically detects when to use interrupt-driven polled comms (in the comms emulation).

For maximum throughput, **MP2500** and **FS3** do not, but can be instructed to use interrupt-driven polled comms by using INT 14H function 33H, so that programs that disable interrupts and poll the UARTs can still be used.

HCOM

On **MP2500**, HCOM supports speeds up to 19,200 Baud (38,400 Baud is not recommended on **MP2500**).

On **FS/2**, HCOM supports speeds up to 38,400 Baud.

On **FS3**, HCOM supports speeds up to 115,000 Baud (with some limitations).

Ports

MP2500 only supports COM2, on Port 1, a 9 way -type.

MP2500 does not support the Fischer port.

The **FS/2** Fischer port is non-standard, requiring a custom driver. The **FS3** Fischer port can be configured as a standard COM1 port.

FS/2 supports TTL and RS232 levels on its comms ports; the **FS3** only supports RS232 levels on Port 1 and Port 2 serial ports, and only TTL levels on Port 3 (Fischer). **MP2500** only supports RS232 levels (on Port 1).

FS3 has an infra red port option configurable as COM2, **MP2500** and **FS/2** do not.

FS3 has a parallel printer port option, **MP2500** and **FS/2** do not.

Keyclick

The **FS/2** keyboard produces a key click, while the **MP2500** and **FS3** keyboards can produce a key click or a more audible beep (INT 16H function 32H).

Sounder

The **MP2500** and **FS3** sounders are optimised for maximum output at 2.0kHz, producing less output than **FS/2** at other frequencies.

Operating system

The standard **MP2500** and **FS3** operating system is MSDOS 6.22. **FS/2** is supplied with MSDOS 3.30a.

MSDOS 6.22 uses more memory than version 3.30a, which may cause problems when loading large applications. The solution is to load parts of the operating system into high memory, by using the HIMEM.SYS memory manager and the DOS=HIGH command:

Operating system	**Free memory**	
DOS 3.30a	589K	**FS/2**
DOS 6.22	578K	**MP2500** and **FS3**
DOS 6.22, loaded high	618K	**MP2500** and **FS3**

RAM backup battery and the MP2500 and FS3 disk

There are two important features of the **MP2500** and **FS3** RAM and Disk:

- **MP2500** and **FS3** use non-volatile CompactFlash as disk. All files stored on this disk are secure irrespective of the state of the main battery or backup battery.
- The **MP2500** RAM backup battery will only support the RAM for 12 to 18 hours (less if not in its fully charged state); the **FS3** RAM backup battery

will only support the RAM for typically 2 to 3 days (less if not in its fully charged state).

All **MP2500** and **FS3** applications **must** therefore be written such that data is frequently saved to disk, as a matter of good practice for data integrity.

On the **FS/2**, all programs and data/files are stored in SRAM (Static RAM) with battery backup.

Memory

FS/2 can only address 1MB of memory directly and can only execute real mode code due to its 8088-class processor.

Unlike **FS/2** which contains SRAM, the DRAM memory in **MP2500** and **FS3** is not used for disk purposes but for program execution. **MP2500** and **FS3** use CompactFlash for disk storage.

MP2500 and **FS3** can address 64MB directly and execute both real mode and protect mode code, due to their 80386sx-class processor; 128K of Upper Memory Block (UMB) is accessible.

Note that DOS extenders, and expanded memory (EMS) using EMM386.EXE are ***not*** supported.

Disk compression

FS/2 does not support disk compression via DRVSPACE.

MP2500 and **FS3** do support disk compression via the DRVSPACE utility supplied with MSDOS 6.22.

Peripheral power

The standard **MP2500** does not provide 5V out.

FS3 and FS/2 provide power (5V out) for external peripherals via their serial port connectors.

G.2 BIOS differences

This section summarises the main differences at BIOS level, between the **MP2500**/**FS3** and **FS/2**.

INT 10H, screen handler

Function 75H, zoom mode: not supported on **MP2500** or **FS3**.

MP2500 and **FS3** support all the **FS/2** screen features, including all text and graphics fonts.

INT 13H, disk services

FS3 implements all INT 13H hard disk for drive C (CompactFlash drive) and an optional ATA PC Card drive. Drive assignment (primary and secondary) is software-controlled.

MP2500 does not support PC Cards.

INT 14H, communications

24H, control CTS: not supported on **MP2500** or **FS3**.

2CH, control DTR: not supported on **MP2500** or **FS3**.

2DH, set comms level: not supported **MP2500** or **FS3**.

34H, disable 8250 emulation: not supported **MP2500** or **FS3**.

INT 15H, BIOS extensions

60H, set clock speed: not supported **MP2500** or **FS3**.

6AH, control SLOW mode: not supported **MP2500** or **FS3**.

71H, power up keys: not supported **MP2500** or **FS3**.

77H, get DOS RAM: not supported **MP2500** or **FS3**.

78H, set DOS RAM: not supported **MP2500** or **FS3**.

88H, get power up keys: not supported **MP2500** or **FS3**.

8BH, set charger temperature override: not supported **MP2500** or **FS3**.

8FH, volume control: not supported **MP2500** or **FS3**.

97H, fast discharge temperature range: not supported **MP2500** or **FS3**.

9EH, LCD contrast compensation: not supported **MP2500** or **FS3** (compensation is automatic instead).

A3H, allow access to overlapping PC-AT INT15 functions

INT 16H, Keyboard services

INT 32H, key sound, click or beep: this function is provided by **MP2500** and **FS3**, but not by **FS/2**

INT 17H, Printer services

FS3 can optionally be supplied with a parallel printer port, **MP2500** and **FS/2** cannot.

INT 19H, DOS boot

FS3 will boot from the CompactFlash drive, internal ATA PC Card drive, or via a PC's drive A connected via a port - which method is used depends on the boot option selected (via the boot option menu - see section 10.3).

MP2500 will boot from the CompactFlash drive or via a PC's drive A connected via Port 1 (COM2).

FS/2 will boot from drive C, or drive A if an Oracle GT is attached via the Fischer port.

INT 1AH, Clock

0AH, read tenths of seconds: not supported (not provided by a standard RTC device).

G.3 Porting FS/2 Applications

There are two main problems when porting an **FS/2** application to **MP2500** or **FS3**:

1. **FS/2 compatibility**: It has not been possible to implement all the **FS/2** features on the **MP2500** or **FS3**. An application that relies on an unsupported **FS/2** function may cause problems.

2. **AT compatibility**: The **FS/2** is an XT-class computer, whereas the **MP2500** and **FS3** are AT-class computers. AT-class computers implement an extended range of BIOS functions, most notably with the INT 15H interface. The **FS/2** INT 15H interface was used to implement **FS/2**-specific functions and some of these overlap with the standard ATA functions, as follows:

Function	Overlap?	Function	Overlap?
00H	no	01H	no
02H	no	03H	no
4FH	no	80H	yes
81H	yes	82H	yes
83H	yes	84H	yes
85H	yes	86H	yes
87H	yes	88H	yes
89H	yes	90H	yes
91H	yes	C0H	no
C1H	no	C2H	no
C3H	no	D8H	no

There are a number of ways to improve **FS/2** compatibility:

- **MP2500** and **FS3** are normally provided with MSDOS 6.22 installed, but as a special option, can be supplied with the same DOS version as **FS/2** (3.30a).

- You will probably need to rewrite any code that uses **FS/2**-specific features.

- Remove any **FS/2** code used to address comms issues such as direct access to the UARTs in native mode for speed - this is neither needed nor supported on **MP2500** or **FS3**.

The **FS/2** private system RAM has been retained in full on **MP2500** and **FS3**, with all **FS/2** locations still valid, so that code that relies on in-depth knowledge of these locations will still function.

The AT compatibility issue can be addressed in one of two ways:

- **MP2500** and **FS3** can be configured as an XT-class machine, so that the INT 15H conflict does not arise.

- **MP2500** and **FS3** INT 15H functions could be relocated so that the conflict does not arise.

Contact your system supplier or **WPI HUSKY TECHNOLOGY LTD** for more details.

G.3 Porting FS3 applications to MP2500

Hardware differences

The **MP2500** hardware is a subset of the **FS3** hardware. The essential differences between **FS3** and a standard **MP2500** are as follows:

- Execution speed 8MHz
- Single serial port (COM2)
- Single power management mode (SPM)
- No parallel port
- No Fischer port
- Backlight is an option
- No PC Card option
- No 5V out power output for peripherals
- No Ring Indicator (RI) input

(Also see section G.1.)

When porting an application to **MP2500**, bear in mind that the performance of the **MP2500** is considerably less than the **FS3**. Applications that require high processing performance or high communications handling should only be considered for porting onto **MP2500** if this reduction in performance is acceptable. However, the reduced power consumption and hardware similarity to the **FS3** may prove beneficial in applications that do not require high performance.

Software differences

When porting an application from **FS3**, the following points should be examined:

- **Single serial port**: Check for references to INT 14H functions which may depend on communications via COM1, the Rack or the Infra Red port.

- **Single power management mode**: Check for references to APM/FPM battery management, which are not supported on **MP2500**. There is no gas gauge facility, no deep discharge facility, and no boost charging option.

IMPORTANT: You must modify any code that depends on loops for timing, such as used for special keyclicks, timing loops and sounder code, as these are dependent on processor speed. (The BIOS automatically compensates for the system keyclick, beep and INT 15H function 82H sound output functions.)

The **MP2500** operating system has been subtly modified to allow use with a single serial port:

- HCOM defaults to use COM2
- XL.COM defaults to use COM2
- UTIL has been modified for a single port
- PCOM.COM defaults to use COM2

Functions that are modified include:

INT 14H, 2EH* Detect RACK
INT 14H, 2FH* Select RACK comms
INT 14H, 32H* Set or clear COM1 Tx bit
INT 14H, 33H* Control input buffering
INT 14H, 37H* Switch COM1 between top connector and Fischer
INT 14H, 38H* Switch COM2 between top connector and IR interface
INT 15H, 61H* Get power level (APM)
INT 15H, 62H* Set low power threshold (APM)
INT 15H, 65H* Authorise charging (APM)
INT 15H, 66H* Set battery level (APM)
INT 15H, 73H* Get diskette power level
INT 15H, 79H Select printer serial port
INT 15H, 7CH Enable/disable hot key power option
INT 15H, 7EH* Control battery change facilities (APM)
INT 15H, 7FH* Get/set battery type (APM)
INT 15H, 80H* Set battery capacity (APM)
INT 15H, 81H* Control power output
INT 15H, 84H Get floppy drive COM1/COM2
INT 15H, 85H* Set/restore power menu (APM)

INT 15H, 89H* Get/set power management mode
INT 15H, 8AH Control power input
INT 15H, 8DH* Get/set boost charge (SPM)
INT 15H, 90H* Set 5V mark/space duration
INT 15H, 93H Get charge status
INT 15H, 96H* Control/monitor fast discharge
INT 15H, 9CH* FPM functions (FPM)
INT 15H, A2H Set printer port type

Functions marked with an asterisk (*) are ignored by the **MP2500** BIOS - they are described briefly below. The other functions are implemented by the **MP2500** BIOS, but with modifications - see Part 3 for details.

Ignored INT 14H functions

The following **FS3** INT 14H functions are ignored by the **MP2500** BIOS:

2EH Detect RACK
2FH Select RACK comms
32H Set or clear COM1 Tx bit
33H Control input buffering
37H Switch COM1 between top connector and Fischer
38H Switch COM2 between top connector and IR interface

Read on for more details.

Detect RACK

Entry AH=2EH

Exit AL=0 (RACK not present) or 1 (RACK present)

Comment On the **FS3**, use this function to detect connection to the FS Communications and Charging Rack. On the standard **MP2500**, the Rack Interface is not available.

Select RACK communications mode

Entry AH=2FH
AL=0 (select normal comms) or 1 (select RACK comms)

Exit Returns nothing

Comment On the **FS3**, use this function to enable or disable RACK communications mode. On the standard **MP2500**, the Rack Interface is not available.

Set or clear COM1 Tx bit

Entry AH=32H
AL=control (0=force high, 1=force low)

Exit Returns nothing

Comment On the **FS3**, use this function to force the COM1 Tx bit high or low. On the standard **MP2500**, there is no COM1 port to control.

Control COM1 input buffering

Entry AH=33H
AL=control (0=disable, non-0=enable)

Exit Returns nothing

Comment On the standard **MP2500**, there is **no** COM1. On the **FS3**, use this function control the COM1 input buffer.

Select Fischer connector

Entry AH=37H
AL=0 (get) or non-0 (set)
If set:
BL=control (0=main port, non-0=Fischer port)

Exit If get:
BL=control (0=main port, non-0=Fischer port)

Comment On the **FS3**, use this function to switch COM1 between the top connector and the Fischer connector. On the standard **MP2500**, there is no COM1 or Fischer port.

Control IR interface

Entry AH=38H
AL=0 (get) or non-0 (set)
If set:
BL=control (0=main connector, non-0=IR interface)

Exit If get:
BL=control (0=main connector, non-0=IR interface)

Comment On the **FS3**, use this function to switch COM2 between the top connector and the optional infra red interface. On the standard **MP2500**, there is no infra red interface.

Ignored INT 15H functions

The following **FS3** INT 15H functions are **ignored** by the **MP2500** BIOS:

61H Get power level (APM)
62H Set low power threshold (APM)
65H Authorise charging (APM)
66H Set battery level (APM)
73H Get diskette power level
7EH Control battery change facilities (APM)
7FH Get/set battery type (APM)

80H Set battery capacity (APM)
81H Control power output
85H Set/restore power menu (APM)
89H Get/set power management mode
8DH Get/set boost charge (SPM)
90H Set 5V mark/space duration
96H Control/monitor fast discharge
9CH FPM functions (FPM)

Read on more for more details.

Get power level (APM)

Entry AH=61H

Exit AH=level

Comment On the **FS3**, this function reads the power level in APM mode. On the **MP2500**, there is no APM mode and the battery level is not monitored, so this function will always return 7FH.

Set low power threshold (APM)

Entry AH=62H
AL=level
BX=interval (1..0258H)

Exit AH=status

Comment On the **FS3**, this function sets the low power threshold for APM mode. On the **MP2500**, there is no APM mode so this function is ignored; instead, low power warnings are issued when the battery voltage falls below a fixed threshold.

Authorise charging (APM)

Entry

AH=65H
AL=charging level
BH=02H (to
BL=03H minimise
CH=04H risk
CL=05H of
DH=06H inadvertent
DL=07H operation)

Exit

AH=status

Comment

On the **FS3**, this function sets the charging authorisation level in APM mode. On the **MP2500** there is no APM mode, so this function has no effect. Battery charging is controlled using the UTIL utility and INT 15, function 8AH.

Set battery level (APM)

Entry

AH=66H
AL=level (0..64H)

Exit

AH=status

Comment

On the **FS3**, this function sets the battery level in APM mode. On the **MP2500** there is no APM mode, so this function has no effect.

Get diskette power level

Entry

AH=73H
AL=drive (0=A:, 1=B:)

Exit

AL=100

Comment

This is a dummy function for compatibility with Hunter 16. Since the **MP2500** will normally only be connected to a PC diskette via its serial port, the drive power is irrelevant and can be assumed to be 100%.

The default level, restored by a cold start, is 0.

Control battery change facilities

Entry AH=7EH
AL=control (0=do not prompt, non-0=prompt)

Exit Returns nothing

Comment On the **FS3**, this function controls how the unit handles a battery change (whether or not it prompts the user) in APM mode. On the **MP2500**, there is no APM mode so this function has no effect.

Get/set battery type (APM)

Entry AH=7FH
AL= 0 (get) or non 0 (set)
BL=battery type, if set (0=non-rechargeable, non 0=rechargeable)

Exit AL=type (0 or 1), if get

Comment On the **FS3**, use this function to set or get the charging mode, in APM mode. On the **MP2500**, there is no APM mode, and charging is controlled using the UTIL utility and INT 15, function 8AH.

Set battery capacity (APM)

Entry AH=80H
AL=0 (get) or non 0 (set)
BL=capacity (0..32H) if set

Exit BL=capacity (0..32H) if get

Comment Use this function on **FS3** to set/get the battery capacity, in APM mode. On the **MP2500**, there is no APM mode or battery level monitoring, so this function is ignored.

Control power output

Entry AH=81H
AL=0 (off) or non 0 (on)
BL=0 (Port 1) or 1 (Port 2 and 3)

Exit Returns nothing

Comment On the **FS3**, use this function to control the +5V output(s). On the standard **MP2500**, there are no power outputs so this function is ignored.

Set/restore power menu (APM)

Entry AH=85H
AL=0 (restore) or 1 (set)
BL=user software interrupt, if set

Exit Returns nothing

Comment Use this function on **FS3** to handle battery changes from within an application, in APM mode. There is no APM mode on **MP2500**, so the function is ignored.

Get/set power management mode

Entry AH=89H
AL=0 (get) or 1 (set)
BL=mode (0=SPM, 1=APM, 2=FPM), if set

Exit AH=00H
BL=current mode (0=SPM, 1=APM, 2=FPM), if get

Comment On the **FS3**, use this function to set or get the power management mode (SPM, APM or FPM). On the **MP2500**, there is only one battery charging mode, similar to the SPM (Standard Power Management) mode of the **FS3**, so this function is ignored.

Get/set boost charge (SPM)

Entry AH=8DH
AL=0 (get) or non 0 (set)
BH=0 (prevent) or non 0 (allow)

Exit AH=0 (success) or FFH (failure)
AL=0 (allowed) or non 0 (prevented), if get

Comment On the **FS3**, use this function to get or set boost charging in SPM mode. On the **MP2500**, there is no boost charging, so this function is ignored.

Set power out mark/space duration

Entry AH=90H
AL=0 (Port 1) or 1 (Port 2 and 3)
BL=0 (disable) or 1..50 (duration)

Exit AH=0 (success) or non 0 (fail)

Comment On the **FS3**, use this function to control the "soft start" of the +5V outputs. On the **MP2500**, there are no power outputs, so this function is ignored.

Control/monitor fast discharge

Entry AH=96H
AL=control (0=start, 1=stop, 2=get status)

Exit AH=0 (success) or non 0 (failure)
AL=status (0=off, 1=on) if get

Comment On the FS3, use this function to get or set fast discharge status. On the **MP2500**, there is no fast discharge facility, so this function is ignored.

The FPM Functions

Entry AH=9CH
AL=FPM function number

Exit Varies

Comment On the **FS3**, use this function to access a range of functions for FPM mode. On the **MP2500**, there is no FPM mode, so these functions are ignored.

G.4 Power Save Features

Introduction

In some applications it has been observed that whilst the **HUSKY FS/2** computer will normally achieve a full working day of operation from a set of charged batteries, an **FS3** running exactly the same application may only achieve between 5 hours. This is typically due to the application keeping the **FS3** continuously in full running mode, and not allowing it to use power save modes. The same problem may affect **MP2500**, but to a much less extent.

If held in running mode the **FS3** draws a continuous 320mA and this equates to 5 hours with a 1600mAh NiCd battery pack. However, this method of continuous operation was not a problem on **FS/2**, which has a running current of only 110mA - easily giving a full working day on its 1400mAh battery, even if the **FS/2** never reverts to power save.

In light of this it is **very important** for system designers to implement their applications with power saving modes in mind. Although **MP2500** uses less power than **FS3**, it does draw a little more current from the battery than **FS/2**. Consequently, **MP2500** battery life also will benefit from attention to power-saving techniques.

The following sections provide some key points to look for when making an application power friendly and give brief tips on improving the performance of existing applications to be ported from **FS/2** to **MP2500** (or **FS3**).

Power Saving Features

The **MP2500** and **FS3** BIOS contain a number of features to help reduce the amount of power consumed by the unit and greatly extend the battery life. The three categories given in section 33.1.4 are shown again below:

Time-outs	Used to conserve power after configured periods with no activity.
Power save modes	HALT and STOP modes are low power consumption modes which are automatically selected by the BIOS when the unit is waiting for something or inactive respectively.
Switchable devices	The backlight (option) and RS232 drivers can be turned off from software in order to conserve power.

Although most of these features are controlled automatically by the BIOS it will usually be necessary to enable or disable them at certain points in an application and to ensure that your code is written in such a way as to allow the features to work.

Both the Time-outs and the power save modes require the unit to become 'idle'. This means that although the processor will be 'busy' doing something, e.g. while waiting for a key, it must not do any significant input / output. The use of any of the following services will postpone automatic power saving functions.

- Screen services via INT10H or direct writing to video RAM
- Disk services via INT13H
- Serial communications via INT14H or direct access to UARTs
- BIOS extension services via INT15H
- Time and Date services via INT1AH
- DOS services via INT21H
- Access to 8253 sound

If your code is written for a compiler which uses ‘standard library routines’ you may not even be aware that these services are being used. Generally, any ongoing I/O (keyboard, screen and disk) functions will prevent the BIOS from evaluating the unit to as idle.

The BIOS can be instructed to allow power save even if some of these functions are in use by using INT15H function AH=8Ch (Get/Set power save entry flag) this is an advanced feature and should only be used with great care.

The instructions contained in the next two sections should be sufficient to get the best power saving out of most applications. Some special cases will be covered in the final section.

Using the BIOS automatic power saving features

In order for the BIOS time-outs to be used, the unit must be in STOP mode for the period configured for the individual time-outs.

Any application which needs to use the automatic BIOS power save features (time-outs and power save modes) should enable STOP mode during its initialisation by using INT15H function AH=76h (see Chapter 26). This needs to be done since the programmer does not know whether or not STOP mode will be enabled when the software is first run. The application default should be to use BX=1, to enable unconditional power save. If any inhibitions are required they should be used where and only where they are required.

The application should also set up both the idle time-out (automatic power off) and the backlight time-out during initialisation by using INT15H function AX=6301h, BX=0 (disable) to E10h seconds (see Chapter 26) and INT10H function AX=6501h, BX=0 (disable) to 12Ch seconds (see Chapter 21) respectively.

Communications and the BIOS automatic power saving features

Any access to the **MP2500** (or **FS3**) serial communications port(s) will cause the BIOS to use HALT mode rather than STOP mode. Although this will result in lower ongoing power usage it will keep the processor active in order to be prepared to receive incoming interrupts and consequently prevent time-outs from being used correctly.

To re-enable STOP mode after communications is complete, the application should follow these steps

- The handshaking lines (RTS and DTR) should be deactivated and any response from the other end waited for. This should ensure that the other end knows that communications has finished.
- The receive and transmit buffers should be flushed and the communications shut down (UART interrupts disabled, service routines re-vectored etc. as appropriate). This will prevent further interrupts and other comms activity from causing the BIOS to go back into HALT mode.
- RS232 drivers should be turned off using INT14H function AH=25H, AL=0, DX=1 (see Chapter 25). (Drivers are automatically reactivated whenever the UART is accessed.)
- Finally, the application should re-enable STOP mode as described in the previous section.

Other situations to look out for

Some applications have special power requirements not covered above or elsewhere in this guide, but generally the same principles will apply for conserving power: when a feature is not actively in use, turn it off.

The two situations below can cause problems if they are not handled very carefully and may require a lot of work to resolve. If battery life is a critical issue it is essential to analyse the power requirements thoroughly to avoid unnecessary or accidental high current consumption.

Using idle time

Some applications will use idle time, such as that available whilst waiting for user input, to perform background tasks. These tasks may include things like updating an on screen clock, monitoring or optimising disk usage, checking communications devices, etc. and should be avoided at all costs.

If it is absolutely necessary to perform such tasks they should be done rarely so as to allow the BIOS to spend as much time as possible in STOP mode.

One way to achieve this is to use the RTC alarm to schedule the tasks at regular intervals rather than allowing them to be ongoing during idle time.

Conclusion

Power saving is an essential part of programming for the **MP2500** and can often be a complicated issue. As such it deserves great attention during the application design phase and should never be neglected. If you require further assistance, please contact your system supplier, or **WPI HUSKY TECHNOLOGY LTD** Support Department.

Appendix H: Technical Notes

From time to time, **WPI HUSKY TECHNOLOGY LTD** issue Technical Notes that provide more detail on specific topics or operational recommendations.

Technical Notes are available from the Support Department at **HUSKY**.

At the time of going to press, the following relevant Technical Notes are available. Please contact your system provider or **WPI HUSKY TECHNOLOGY LTD** for an up-to-date list.

Note#	Issue#	Title
526	1	BIOS Powersave Features.
529	1	Sounder Volume.
530	2	**FS** and **MP2500** Batteries.

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Index

6845 emulation, 296

9-way D type, 340

AC adaptor
  connecting, 46
  using to charge batteries, 45
  using to power the MP2500, 51
Accessories, 161
Adapting applications
  fine tuning, 173
  MS-DOS applications, 173
  PC-DOS applications, 173
Adjusting the LCD, 29
Alkaline batteries, 49
APM mode, 89
Applications
  adapting, 173
  installing, 165
ASCII character set, 325
AUTOEXEC.BAT
  contents of, 19, 169
Automatic power off, 53, 88
Autorepeat, 89
Auxiliary serial port, 1

Backlight
  timeout, 88
  timeout mode, 256
  using, 30
Backup battery
  battery life, 43
  charging, 52
  purpose, 47
Batteries, 43
  - introduction, 43
  backup battery, 43
  battery life - alkalines, 49
  battery life - backup, 52
  battery life - NiCds, 44, 47, 48
  battery life - NiMH, 44, 47, 48
  calculating battery life, 311
  changing batteries, 50
  disposing of batteries, 42
  fast discharge, 47
  main batteries, 15
  maximising rechargeable battery life, 47
  memory effect, 47
  monitoring, 18
  recharging, 45
  recycling batteries, 42
  self-discharge - rechargeables, 45
  shelf life - alkalines, 49
  shelf life - rechargeables, 45
  temperature effects, 44, 45, 47, 49
  using Alkaline batteries, 49
  using NiCds, 44
  when to change, 49
  when to recharge, 44
Battery backup, 52
BIOS extension functions interrupt (15H), 233
  acknowledge event, 242
  Backlight timeout mode, 256
  control charging in SPM, 250
  control HOT key, 246
  control HOT key power option, 246
  control power down, 238
  control power save, 244
  control Resume mode, 237
  control screen synchronisation, 249
  control sound, 242
  control STOP mode, 237
  enable/trap event, 241
  get charging status, 252

get customer id, 256
get event details, 239
get idle timeout, 236
get machine information, 253
get power save entry flag, 251
get printer port type, 249, 259, 261, 262
get ROM BIOS version number, 239
get screen attribute table, 249
get serial number, 239
get unit serial number, 255
invoke HOT key, 245
override low power turn off, 247
power down, 238
redirect serial number, 243
reset machine information, 252
resynchronise system clock, 256
select serial port for redirected printing, 245
select soft font, 253
set 11x8 text font, 257
set 16x16 text font, 258
set backlight power up state, 243
set contrast power up state, 244
set idle timeout, 236
set power save entry flag, 251
set printer port type, 249, 259, 261, 262
set screen attribute table, 249
sound output, 247
BIOS interrupts, 175
INT 05H, 179
INT 10H, 181
INT 11H, 201
INT 12H, 203
INT 13H, 205
INT 14H, 217
INT 15H, 233
INT 16H, 263
INT 17H, 279
INT 19H, 283
INT 1AH, 285
BIOS revisions, 341
BIOS upgrades, 162
Boot Option menu, 76
Booting, 16, 21, 27
and the system files, 19
Boot Option menu, 76
from a diskette, 77
Break key, 37
British Summer Time (BST), 71
Buffering communications, 121

Case
cleaning, 41
construction, 315
resistance to pressure, 323
sealing, 42, 321
CGA compatibility, 29
CGA emulation, 296
character set, 299
colour select register, 298
display RAM, 296
lightpen register, 299
mode control register, 298
status register, 298
Changing alkaline batteries, 49, 50
Changing NiCds, 47
Changing rechargeable batteries, 48
Character set, 299, 325
Charging authorisation, 46, 54
Charging batteries, 45
Charging support
displaying, 86
Check memory size interrupt (12H), 203
Check system equipment interrupt (11H), 201
Cleaning
the case, 41
the keyboard, 60
the LCD, 28, 30, 41
Clock

accuracy, 318
and British Summer Time, 71
and Daylight Saving, 71
and leap years, 71
problems with, 66
setting for the first time, 17
setting the date, 71
setting the time, 71
temperature effects, 321
Clock handler interrupt (1AH), 285
disable RTC alarm, 289
get RTC alarm time, 289
get RTC date, 288
get RTC time, 287
get system clock, 286
set RTC alarm, 288
set RTC date, 288
set RTC time, 287
set system clock, 286
set system clock source, 290
Cold start, 16, 175, 177
Colour graphics adaptor, 1
Colours on the LCD, 32
COM2, 73
COMMAND.COM, 38
Communicating with
a modem, 142
another MP2500, 140, 158
Hunter 16, 141, 158
personal computers - serial, 143
serial printers, 146
Communications
- introduction, 119
- introduction to using, 149
and interface power, 150
background information, 121
buffering, 121
communications packages, 120
configuring Husky communications, 128
configuring IBM communications, 139
connecting to COM2, 123
errors, 158
handshaking, 125
IBM communications - configuring, 139
IBM communications - selecting, 73
MODE command, 139
MP2500 communications - configuring, 120
MP2500 communications - description, 120
MP2500 communications - selecting, 73, 123
ports, 120
selecting the mode, 73
starting communication, 150
using MP2500 applications, 156
using MS-DOS applications, 156
using MS-DOS comms packages, 157
using the standard facilities, 150
Communications configuration, 73, 123
CTS, 128
DCD, 128
DSR, 129
DTR, 129
ECHO, 130
LENGTH, 131
LF, 131
MP2500 MODE, 130
NULL, 132
PARITY, 133
PROTOCOL, 134
RTS, 134
RX T/O, 135
SERIG, 136
SPEED, 137
STOP, 137
TX T/O, 137
Communications protocols

- introduction, 126
NONE, 126
XON/XOFF, 127
CompactFlash drive
formatting, 80
CONFIG.SYS
contents of, 19, 169
Configuring
applications, 168
backlight timeout, 88
calendar, 71
clock, 71
IBM communications, 139
idle timeout, 88
keyboard, 88
MP2500 communications, 73, 123
MS-DOS, 19
operation, 18
power, 89
screen, 86
Connectors
- introduction, 339
9-way (ports 1 & 2), 340
Contrast, 29
Controlling
power handling, 89
the keyboard, 88
the LCD, 29, 86
Conventions, 9
Copy protection, 165
Ctrl Alt Del, 27
Ctrl Break, 37
Cursor visibility, 87
Customer id, 256
Customer support, 1

Date
displaying, 86
setting, 71
Daylight Saving Time, 71
Decimal to Hexadecimal, 327
Deep discharge, 47
Developer keyboard, 34, 329
Device emulations, 295
6845, 296
Dimensions, 315
Disk handler interrupt (13H), 205
alternate reset disk, 213
controller drive diagnostic, 214
controller internal diagnostic, 215
controller RAM diagnostic, 214
format bad track, 210
format disk cylinder, 209
format drive, 210
get disk type, 215
initialise drive parameters, 211
read drive parameters, 211
read long sector, 211
read sectors, 207
read test buffer, 213
recalibrate drive, 214
reset disk status, 207
reset disks, 207
seek to cylinder, 212
test for drive ready, 214
verify sectors, 208
write long sector, 212
write sectors, 208
write test buffer, 213
Display, 1
Display RAM, 296
Disposing of batteries, 42
Drive C
displaying free space, 38
formatting, 66
system files, 19
Drive D
displaying free space, 38
Dustproofing, 42

ED
- introduction, 91
and CR, 92
and TAB characters, 93

browse mode, 93
case sensitivity, 92
changing option settings, 111
command keys, 100
command options, 92
control keys, 100
default path, 91
error messages, 115
facilities summary, 96
file format, 91
file handling, 91
file size, 92
function keys, 100
insert mode, 94, 97, 104
keys, 100
line end character, 92
line end indicators, 96
line wrapping, 93
overtype mode, 94, 97, 104
screen layout, 94
special keys, 101
text font, 93
typing modes, 94, 97, 104
ED commands
- summary, 96
BLOCK COPY, 101
BLOCK DELETE, 102
BLOCK END, 103
BLOCK MOVE, 102
BLOCK START, 103
BLOCK WRITE, 103
CHARACTER INSERT, 104
CURSOR KEYS, 105
DELETE FILE, 105
DELETE LEFT, 105
DELETE RIGHT, 105
DIRECTORY, 106
error messages, 115
EXIT, 107
FILE END, 107
FILE START, 107
FIND, 107
keys, 100
LINE DELETE, 108
LINE END, 108
LINE START, 108
PAGE DOWN, 109
PAGE UP, 109
PRINT SCREEN, 109
READ FILE, 109
REPLACE, 110
SAVE, 111
SET, 111
TAB, 113
UNDELETE, 113
VIEW FILE, 114
WORD DELETE, 114
WORD SKIP, 114
ED options
60, 93
BROWSE, 93
IGNORE, 92
KEY, 93
LF, 92
TAB, 93
WRAP, 93
Electromagnetic compatibility, 323
EMC legislation, 40, 323
Error messages
communications, 158
ED, 115
general, 61
Expansion, 58
power sources, 161
software upgrades, 162

Fast discharge, 47
File transfer utilities, 152, 153
FLASH EPROM
and the BIOS, 317
FLASHBAK utility, 52
Flip screen key, 30
Foreign keyboard support, 19
Formatting

CompactFlash drive, 80
Formatting drive C, 66
FS/2 and MP2500 compatibility, 341
FS3 and MP2500 compatibility, 341
Function keys, 37

Guarantee, 58

Handstrap, 14, 55
removing, 55
replacing, 56
Hardware
- introduction, 291
device emulations, 295
I/O addresses, 293
interrupts, 175, 295
logical memory, 292
physical memory, 292
Hardware interrupts, 175
HCOM utility, 152
Hexadecimal to Decimal, 327
HOT key, 38, 85
- introduction, 85
autorepeat, 89
inverse video, 87
keyboard option, 88
power option, 89
screen option, 86
screen synchronisation, 87
split screen, 87
status information, 86
text font, 86
turn off timeout, 88
using, 85
Humidity indicator, 41
Husky communications, 73
Husky Utilities Disk, 77, 80
Husky web site, 6

I.COM, 19
I/O address decoding, 293
IBM communications
configuring, 139
selecting, 73
IBM compatibility, 29, 165, 175, 291
Idle timeout, 54
Installing applications
- introduction, 165
compatibility, 165
configuring the application, 168
copy protection, 165
copying files, 168
special considerations, 170
testing, 170
Interfaces, 339
INTERLINK utility, 82
International keyboard support, 19
Interrupts
- introduction, 175
- summary, 176
BIOS, 177
hardware interrupts, 175, 295
microprocessor interrupts, 175
types, 175
vectors, 175
INTRODUCTION TO
adapting applications, 173
batteries, 43
communications, 119
communications protocols, 126
device emulations, 295
ED, 91
handshaking, 125
hardware, 291
HOT key, 85
installing applications, 165
interrupts, 175
keyboard, 33
looking after MP2500, 41
MP2500, 1
power, 43
programming MP2500, 163
the guides, 5

the LCD, 28
the screen, 28
this guide, 7
using communications, 149
UTIL, 69
Inverse video, 32, 87

Keyboard
- introduction, 33
autorepeat, 89
cleaning, 60
configuring, 19, 88
controls summary, 37
developer keyboard, 34, 329
differences from IBM, 37
foreign, 19
HOT key, 38
international, 19
layout, 35, 329
matrix codes, 332
modes, 34
overlay, 57
redefine key codes, 271
redefine PAW key codes, 274
redefine scan codes, 273
scan code, 333
select keyboard mode, 275
selecting keyboard modes, 34
special keys, 37
the PAW key, 37
user keyboard, 34, 330
Keyboard handler interrupt (16H), 263
clear keyboard buffer, 276
control Break keys, 274
control Ctrl Alt Del, 269
control emergency breakout, 270
control key repeat, 273
control keyclick, 272
control shift keys, 269
extended get key, 267
extended get shift status, 267
extended get status, 267
get key, 264
get key repeat, 272
get shift status, 265
get status, 264
redefine key codes, 271
redefine PAW key codes, 274
redefine scan codes, 273
reset extra keyboard variables, 275
reset keyboard, 271
select keyboard, 275
select keyclick sound, 277
set key repeat, 265
set temporary shift, 268
write to buffer, 266
Keyboard overlay, 57
Keys
- summary, 33
backlight keys, 30
contrast keys, 17, 29
control keys, 37
flip key, 30
function keys, 37
HOT key, 38, 85
international characters, 19
looking keys, 30
PAW key, 37
power key, 16, 27
reboot keys, 21
select keyboard mode key, 34
typing keys, 35
viewing keys, 30

LCD
- introduction, 28
adjusting, 29
and the CGA, 30
and the virtual screen, 30
backlight, 30
backlight timeout, 88
CGA compatibility, 29

cleaning, 28, 30
colours, 32
contrast, 29
controls, 29, 86
cursor synchronisation, 87
flip screen key, 30
inverse video, 32, 87
looking keys, 30
scrolling, 87
split screen, 31, 87
text attributes, 32
text font, 86
viewing angle, 29
viewing keys, 30
virtual screen, 29, 30
window, 30
Leap years, 71
Logical memory, 292
Looking after MP2500, 41
Looking after the LCD, 28, 30
Looking keys, 30
Low power
power-down, 53
warning, 53

Main serial port, 1
Maintenance, 41
Memory
FLASH EPROM, 317
logical memory map, 292
maps, 292
physical memory map, 292
types used, 317
Memory effect, 47
Microprocessor interrupts, 175
MODE command, 139
MP2500 communications
advantages, 120
configuring, 120
selecting, 73
MS-DOS
adapting applications, 173
compatibility with IBM, 38
configuring, 19
system files, 19
utilities provided, 38

NiCds, 44

Operating environment, 321
electromagnetic compatibility, 323
humidity, 321
pressure and elevation, 323
shock, vibration, impact, 323
storage conditions, 322
temperature, 60, 321
waterproofing and dustproofing, 321
Operating temperature range, 60, 321
Options, 161
ORACLE utility, 79

PAW key, 37
PC-DOS, 173
Physical memory, 292
Port 1
configuring, 73
connecting to, 123
using, 119
Porting applications
from FS/2, 341
from FS3, 341
Power, 43
- introduction, 43
backup, 52
charging authorisation, 54
connecting the AC adaptor, 46
consumption calculations, 311
idle timeout, 54
low power warning, 53
management modes, 18
options, 161

power management modes, 52, 305
power save mechanism, 54
power sources, 43
power-off timeouts, 308
setting up, 312
sources, 43
usage calculations, 311
using an AC adaptor, 51
using fast discharge, 47
using recharging, 45, 314
Power down, 27
Power handling subsystem
- introduction, 52
- summary, 301
charging, 305
controlling power-down, 304
facilities, 301
idle timeout, 304
low power, 304
power loss, 305
power management modes, 305
power modes, 307
power monitoring, 305
power-down causes, 303
power-down function, 304
power-down key, 304
power-saving, 306
power-up causes, 301
power-up keys, 302
power-up state, 302
SPM mode, 305
Power management modes, 18, 305
Power on, 16
Print screen interrupt (05H), 179
Printer control interrupt (17H), 279
get printer status, 281
initialise printer, 280
print byte, 280
Problems
- introduction, 59
can't power down, 63
can't power up, 61
can't quit application, 62
communications error messages, 158
ED error messages, 115
error messages, 61
LCD blank, 61
program errors, 59
solving problems, 61
use outside temperature range, 60
with clock, 66
with comms parameters, 66
with drive C, 66
with keyboard, 60, 64
Programming
- introduction, 163
check memory size, 203
check system equipment, 201
interrupts, 175
miscellaneous extensions, 233
print screen, 179
reboot, 283
the disks, 205
the hardware, 291
the keyboard, 263
the power handling system, 301
the printer, 279
the RTC, 285
the screen, 181
the serial ports, 217

Reboot interrupt (19H), 283
Rebooting, 21
Rechargeable batteries, 44
Recharging batteries
charging authorisation, 46
procedure, 45
reasons for failure, 46
when to recharge, 44
Recycling batteries, 42
Repairs, 58
Replacing alkaline batteries, 49, 50

Replacing NiCds, 47
Replacing rechargeable batteries, 48
Reset, 27
Reversed text, 32
Routine maintenance, 41
RS232, 119
RTC, 17

Screen, 28
Screen handler interrupt (10H), 181
  draw ellipse/circle, 192
  draw line/box, 193
  get backlight state, 199
  get backlight timeout, 191
  get contrast state, 199
  get cursor address, 184
  get cursor position, 184
  get cursor position (graphics), 191
  get graphics font, 197
  get video state, 188
  looking keys, 197
  move cursor, 184
  move cursor (graphics), 190
  read character and attributes, 186
  read pixel, 188
  reset screen parameters, 198
  scroll down, 186
  scroll up, 185
  select text font, 195
  set backlight timeout, 191
  set bold attribute mask, 199
  set contrast, 191
  set cursor size, 183
  set display page, 185
  set graphics font, 189
  set inverse video mechanism, 194
  set LCD window position, 196
  set screen mode, 183
  split display, 192
  turn backlight on/off, 198
  write character, 187
  write character and attributes, 186
  write character as TTY, 188
  write pixel, 187
  write string, 189
Screen synchronisation, 249
Screen window, 29
  automatic movement, 29
  moving, 30
  size, 28
  splitting, 31
Sealing, 42
Serial number
  reading, 239, 255
  storing in RAM, 243
Serial port handler interrupt (14H), 217
  check status, 221
  control handshake line, 229
  control RI power up, 230
  extended control, 228
  extended initialise port, 221
  extended protocol menu, 231
  extended status, 229
  get extended protocol parameters, 231
  get installed protocols count, 230
  get protocol handle, 231
  get protocol name, 230
  initialise port, 219
  input character, 221
  NMI suspend, 232
  read comms parameters, 222
  select comms parameters, 225
  send character, 220
Serial ports, 1
Setting the date, 71
Setting the time, 71
Shelf life, 58
Shell life, 322
Sockets, 339
Software upgrades, 162
Solving problems, 61
Sound output interrupt, 247

Special keys, 37
Specification, 315
Split screen, 31, 87
SPM mode, 89
Status information, 86
Status key, 38
Status line, 31
Storing MP2500, 58, 322
Synchronising scrolling, 87
System editor, 91
System files, 19, 21
System utilities, 69

Temperature range, 60, 321
Text
  attributes, 32
  colours, 32
  fonts, 86
Time
  displaying, 86
  setting, 71
Timeouts
  backlight, 88
  idle turn off, 88
Transferring files, 152, 153
Troubleshooting, 59
Turning off, 27
Turning on, 16
Typefaces, 9

Unit serial number, 255
Upgrades, 58
Upgrades to the BIOS, 162
User keyboard, 34, 330
UTIL
  - introduction, 69
  communication port 1 setup, 73
  format diskette option, 72
  set date option, 71
  set time option, 71
Utilities
  - summary, 38
  Boot Option menu, 76
  FLASHBAK (FLASH EPROM), 52
  FLSHBIOS (BIOS update loader), 162
  HCOM (file transfer), 152
  HOT key (misc. functions), 85
  I (international keyboard support), 19
  INTERLINK, 82
  MS-DOS, 38
  ORACLE, 79
  upgrades, 162
  UTIL (misc. functions), 69
  XL (XMODEM file loader), 153

Vectors, 175
Viewing angle, 29
Viewing keys, 30
Virtual screen, 29, 30

Warranty, 58
Waterproofing, 42
Web site, 6
Welcome screen, 16, 28
Window, 29
  automatic movement, 29
  moving, 30
  size, 28
  splitting, 31

XL utility, 153
XMODEM loader utility, 153
XON/XOFF protocol, 127